ELECTRICAL ENGINEERING

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The Cover: Underwater application of closed-circuit television is enabling U. S. Fish and Wildlife Service to observe and test remotely the performance of experimental fishery methods and equipment under actual oceanic conditions. Atop of the submersible "diving bell," which houses a television camera, is a watertight electrically driven power unit which permits remote control of camera's scan. (See "Of Current Interest," page 1024.)

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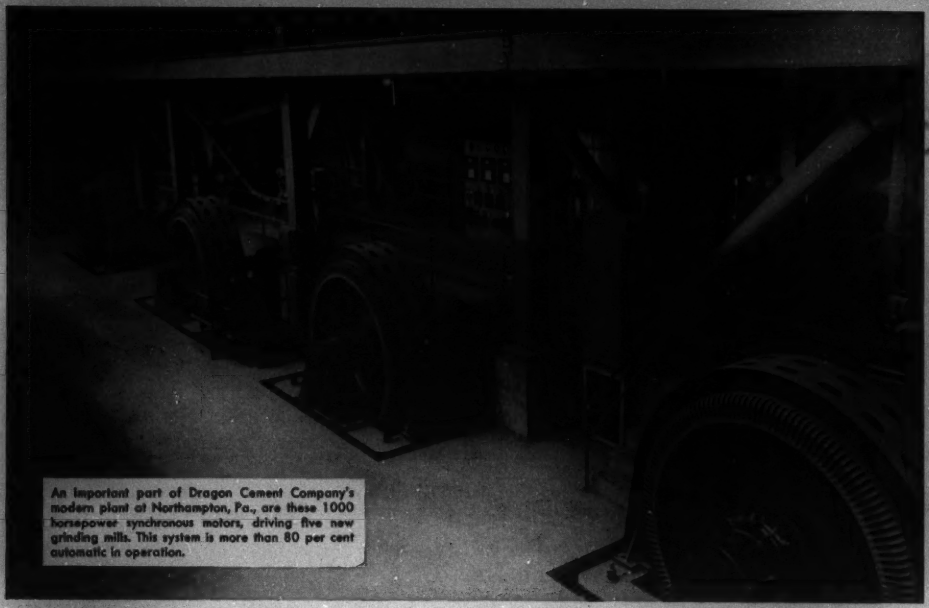

An important part of Dragon Cement Company's modern plant at Northampton, Pa., are these 1000 horsepower synchronous motors, driving five new grinding mills. This system is more than 80 per cent automatic in operation.

80% automatic, this plant specified OKOLITE-OKOPRENE cables

Since Dragon Cement Company's new mill was to represent the latest developments in cement making techniques, process control and automation were given the greatest consideration. This necessitated a reliable electrical power distribution system with dependable control circuits.

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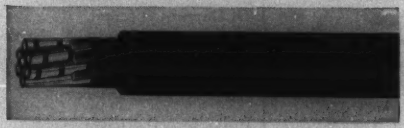
Dragon Cement Company is following a nation-wide trend of manufacturers to Okolite-Okoprene cables for circuits that must not fail. Okolite oil-base insulation, made from natural wild up-river Fine Para rubber, is moisture-, ozone-, and heat-resistant. The Okoprene sheath gives maximum protection from most harmful acids, oils and chemicals. In addition, because Okoprene's high surface resistivity prevents heavy longitudinal drainage currents, these cables are used in many



utility and industrial plants *unshielded* up to 5000 volts. When you order cable for circuits that must not fail, specify Okolite-Okoprene. Write for our new Bulletin EG-1085 for full details. The Okonite Company, Passaic, N. J.

OKONITE SINCE 1878 *insulated cables*

2947

HIGHLIGHTS.....

Solidarity of the Profession. "... Unity of organization may or may not be a desirable goal... Unity of performance, however—the kind of unity which electrical engineers assume is theirs without analysis—is the kind of unity that the entire profession could well emulate." These are words spoken by President Hooven in his address before the General Assembly, Fall General Meeting, Chicago, Ill., October 3–7 (*pp. 953–4*).

A New Temperature Relay for Use with Resistance Temperature Detectors. Electric equipment requires the use of automatic devices for protection against damage. This article describes an improved form of temperature relay, similar in construction to a watthour meter, which can detect more accurately than before a specific temperature condition in any protected piece of equipment (*pp. 998–1001*).

Satellite- and Booster-Station Allocation Developments. Many factors have led the FCC and broadcasters to make use of auxiliary stations to rebroadcast programs of parent stations on either the same or different frequencies. Several auxiliary stations have been authorized, but policy regarding their operation is in a state of flux (*pp. 962–6*).

Techniques for the Utilization and Modification of Encapsulating Resins. The protection and maintenance of electronic equipment and components under conditions of high humidity, rough handling, and thermal shock require the use of encapsulating materials used as impregnants, coatings, plotting compounds, and embedding media. Special qualities and applications of these materials are discussed (*pp. 990–2*).

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Automation for Freight Yards. The system now operating for automatically controlling the movement of cars into classification tracks in gravity freight yards is described. This system offers many advantages over manually controlled operations (*pp. 986–90*).

Emergency Electric Systems for Jet Aircraft. The author discusses the importance of providing emergency power in various types of jet aircraft, in case of failure of the primary power system. Detailed descriptions of several of these emergency systems are included (*pp. 1004–6*).

Prediction of Electronic Equipment Reliability. Inherent reliability of naval shipboard equipment may be considered as the capability of the design to operate without failure in its assigned task. The prediction of failure rate described is based on a permanent Navy system of data collection (*pp. 994–7*).

Operation of a Nuclear Power Plant on an Integrated Electric System. This article answers some of the questions arising concerning the operation of nuclear power plants that will be of interest to electrical-utility engineers. Comparisons are made with steam-generator requirements (*pp. 980–3*).

Solar Energy. Research for substitute energy sources should not be delayed as the coal, gas, and oil reserves are being consumed at a rapid rate. This article tells how the sun's energy is being used presently as a fuel substitute, and how this energy may be used and controlled in the future (*pp. 959–61*).

Development in Closed-Circuit Television. The author explains the newly developed television distribution system and 2-way television system, which have practical uses in many fields. Two recent installations of the systems are described (*pp. 974–9*).

Modernizing Service Controls on Rapid Transit. The Chicago Transit Authority has designed new methods to provide better service to customers as well as to keep the price of the service within limits. New practices are being used for despatching trains, recording train movements, and for direct communication to operating personnel and passengers. Control and communication equipment are described (*pp. 966–71*).

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Management of an Engineering Organization. The three most important functions the managing engineer must perform are the planning, control, and appraisal of performance. For engineers, who have obtained a high degree of engineering competence and have the aptitude and desire for managerial work, the field is rewarding (*pp. 955–8*).

Winter General Meeting. Information concerning technical sessions, hotel reservations, and social activities for the Winter General Meeting, which will be held January 30–February 3, 1956, at the Hotels Statler and Governor Clinton in New York, N. Y., is included in this issue. Approximately 380 papers and 95 technical sessions are anticipated for the meeting (*p. 1010*).

AIEE Fellows. Biographical sketches of members recently elected to the grade of Fellow in the Institute are presented (*pp. 1015–7*).

Mercury-Xenon Lamp. The lamp described in the article "1000-Watt Short-Arc Mercury-Xenon Lamp for the U. S. Navy," which appeared on page 813 in the September issue, was developed by Westinghouse Electric Company, Bloomfield, N. J.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

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SOLIDARITY of the Profession

M. D. HOOVEN
PRESIDENT AIEE

"Solidarity of the electrical engineering profession is a characteristic inherent in the profession itself," according to M. D. Hooven, AIEE President. "Where a common purpose or a common effort is required...common participation is assured." President Hooven tells of joint efforts in the profession, of individuals participating in more than one of the associations, and particularly of AIEE's relation to its affiliates.

SOLIDARITY of the electrical engineering profession is a characteristic inherent in the profession itself. While minor deviations or divisions of organization may occur, there is within the profession no division of purpose or of action. Typical of this unity of action is the National Electronics Conference (NEC) being held concurrently with these Institute sessions. AIEE is one of the sponsors of NEC, as is the Institute of Radio Engineers. This is the eleventh consecutive year in which the conference has been held in Chicago, Ill., during the fall season. I remember serving on the Technical Program Committee in 1944 and a long discussion of papers which might be contributed to the new conference. I assume such discussions still continue as I have been told that papers given at the NEC can, under the present routine of the Committee on Technical Operations, be accepted as AIEE *Transactions* papers. One hundred papers will be presented at NEC, making a total of 250 to be given in Chicago in one week.

The same degree of co-operation and co-ordination is, of course, effective among other elements of the electrical engineering profession. In March of 1956, AIEE will take part in the American Power Conference, another annual affair traditionally held in Chicago. At least 20 technical conferences are planned for the coming administrative year, to be held in 20 localities. In half of these AIEE will work with its associates in providing forums for technical papers and discussion. There are, in addition, approximately 200 sessions planned within the Institute itself. Beyond these formally-planned technical sessions, the number of joint Section or Branch meetings, such as held by AIEE–Institute of Radio Engineers (IRE) Joint Student Branches, is difficult to tabulate. There are many hundreds.

Full text of address presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 3–7, 1955.

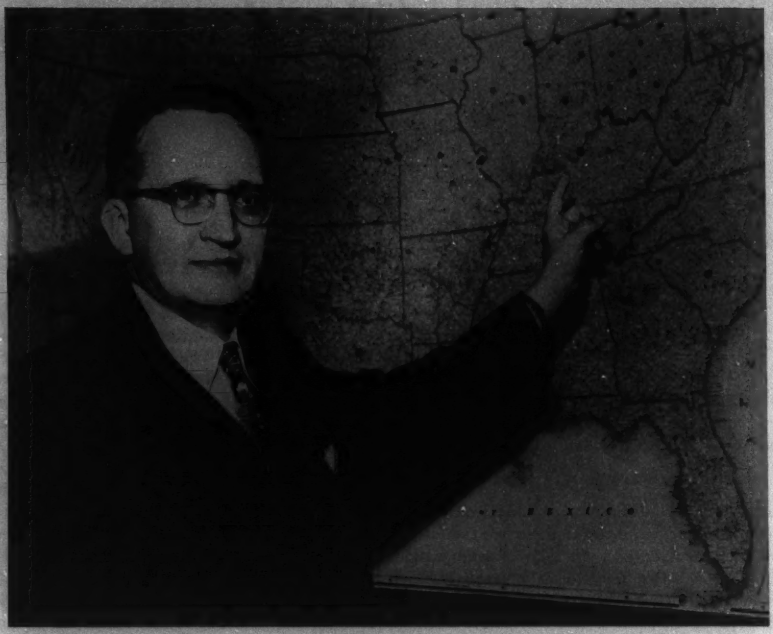
M. D. Hooven is electrical engineer with the Public Service Electric and Gas Company, Newark, N. J.

Some decry the fact that, to the rest of the world at least, the electrical profession seems to include many dissociated bodies. I have mentioned the National Electronics Conference, the Institute of Radio Engineers, and the American Power Conference. One might add the Illuminating Engineering Society (IES), the Association of Iron and Steel Engineers, the engineering groups of the Edison Electrical Institute, the Association of Edison Illuminating Companies, the National Electrical Manufacturers Association, the Radio Electronic Television Manufacturers Association, Instrument Society of America, and similar bodies. Do we constitute a house divided against itself? Not at all. The participants in the technical activities of these many associations are all electrical engineers possessed of the same education, speakers of the same language.

AIEE, IRE, and IES, even allowing for duplication, will soon account for 100,000 individual members of the same profession and there probably are some 25,000 unaffiliated with any of the great technical societies. Of these 125,000 electrical engineers some 40,000 have been added to the profession since the end of the war. In other words, one out of every three electrical engineers is a product of the last 10 years. While there is no need to illustrate the cohesiveness of the profession to the older two out of every three electrical engineers, it might be wise to use this opportunity to say that where a common purpose or a common effort is required, as the NEC illustrates so well, common participation is assured. The IRE-AIEE situation interests me greatly. A recent memorandum by Mr. I. S. Coggeshall, chairman of the Communication Division of AIEE and a Past President of IRE, concerns internal groupings within both institutes. Both have recognized the need of subdivision to meet specialized interest. AIEE has five divisions consisting of 43 technical committees; IRE's corresponding organization has 24 semiautonomous professional groups. Whether or not the organizational coverage of one is better than the other is not the subject under discussion. The point seems to be that rapidly increasing specialization is apparent within the electrical engineering profession.

AIEE is particularly fortunate in that being the parent body, as it were, it can help its associates in many and diverse fields and conversely obtain help in varying areas.

It is interesting to turn back the pages of history to the immediate post World War II period in AIEE when President W. E. Wickenden constituted a special subcommittee to survey the technical activities of the Institute. Beside



M. D. Hooven

myself, the subcommittee consisted of four men, Messrs. F. A. Cowan, S. G. Hibben, H. M. Turner, and R. J. Wiseman, chosen for their AIEE activity. Mr. Cowan, an Edison medalist, is a prolific writer in many fields; Dr. Hibben is a Past President of IES; Professor Turner, a Past President of IRE; Dr. Wiseman, a Past President of the Insulated Power Cable Engineers Association. Dr. W. R. G. Baker was the first chairman of the then newly constituted Communications Division and among the most active participants in the deliberations concerning AIEE specialization; similarly, in IRE he is regarded as the parent of the professional group activity. Dr. J. D. Ryder, President of IRE, is chairman of NEC's Awards Committee and active in many AIEE committees. This same leaven of scattered personal contribution is at work in all of our related electrical societies.

By circumstance the electrical engineers seem to constitute the hard core of the engineering profession as a whole. In this day of intensive utilization of energy, the electrical engineer transmits it, converts it, controls it, or communicates with it. If the new machine age is to be a thinking-machine age, it will be the electrical engineer who will perforce design the thinking machine. Because electrical engineers are in the middle of engineering activity—and not at all because they are any better or worse than their brothers in civil, mining, mechanical, or chemical engineering—it has fallen to the lot of AIEE to carry reasonably heavy burdens in the general professional field. AIEE represents the electrical engineering profession on the two councils which concern themselves with the problems of the whole profession, the Engineers Council for Professional Development (ECPD) and Engineers Joint Council (EJC), the one seeking to carry responsibility for intraprofessional activities and the other for extraprofessional activities, ECPD in the field of education has, within the 20-year period behind it, done much to keep high the threshold of admittance into the profession. EJC, in its much shorter life, has held out to all engineers the possibility of the eventual attainment of unity of organization to enhance the solidarity of purpose and action already achieved within the profession. This organizational unity, of course, may or may not be a desirable goal. The unity of performance, however—the kind of unity which electrical engineers assume is theirs without analysis—is the kind of unity that the entire profession could well emulate. These electrical engineering associations serve well their segments of the profession without any formal organizational unity.

AIEE, the parent body of electrical engineers, bears its responsibility proudly. It hopes to be the first to support, the first to encourage the activities of its affiliates. It aspires to share any intellectual resources which it may have with its associates. It asks nothing in return except the advancement of the art and the progress of the profession.

Management of an Engineering Organization

C. J. BELLER
FELLOW AIEE

The three principal functions the managing engineer must perform are outlined in their logical order. Areas related to the basic ones of planning, control, and appraisal of performance are also indicated.

THE three most important functions of the managing engineer are the planning, control, and appraisal of performance. These are in their logical order of sequence. Each of these functions, when analyzed, is highly complex, and many volumes could and have been written on each one. Another way to state these functions is before action planning, during action review, and after action analysis.

PLANNING

PLANNING is the first function that must be performed in any organization. No engineering project can be started, no production can be realized, and no service can be rendered without adequate planning beforehand.

Planning can be broken down in many ways. One of these relates to time. For instance, much planning must be done for the very near-term future. In general, this is done at lower levels in the organization. Then there is planning for from 1 to 5 years in advance, and there is the broad-gauge type of planning as far in advance as 20 or more years. It seems safe to say that the higher the managing engineer is in the organization, the more time he will and should have to spend on planning.

One important point in short- and intermediate-term planning is to be sure it is consistent with the long-term plans. Many millions of dollars are wasted every year undoing things that never would have been done if the long-term plan had been investigated first. Failure to consider the long-term plan can be very costly.

Before any planning of any importance can be done, it is necessary to know what it is desired to accomplish, what are the over-all objectives of the company, and what are the corresponding objectives of each organizational element of the company. An adequate job of planning cannot be done unless the objectives to be accomplished by these plans are known. Unless the objectives are stated in writing, it is doubtful if they have been adequately thought out. Nothing clarifies thinking so well as putting the thoughts down on paper.

Assuming the objectives are properly covered, to do proper planning one must know as accurately as possible what to expect in the future. Determining this is the process of forecasting. It includes such elements as predicting The Federal Reserve Board or other industry indexes of business activity for the coming years; an appraisal of what is to be expected in the areas of public relations, labor relations, and governmental legislation; an estimate of what price levels can be expected for labor, raw materials, and finished products; whether there will be a plentiful supply of labor; and many others, depending on the objectives of the organization. Future technological development must also be considered. For instance, in future plans for the electric power industry, the impact of atomic energy would certainly need to be considered. In other words, before effective plans can be made, the business climate in which the plans are to be carried out must be determined.

Because planning for the future depends to such an important extent on such forecasts, a considerable amount of research on the subject can generally be justified. It is good procedure to obtain the judgment of a fairly representative group of experts on each item. Use should be made of specialists within the organization, outside experts and consultants, trade association forecasters, and others who might be helpful. After the thinking of all of these sources is analyzed, the final determination of the forecast should generally be made by one or more individuals in the company.

Another important phase of planning is organization planning. Without the proper organization, the top executives will not have time to plan. It has been said that, "The lack of adequate planning frequently results from the fact that top executives are too preoccupied with matters of a current nature to concentrate upon the future needs of the business."[1]

The organization should be checked to determine if it is the best for the present needs. Some of the areas to be considered are organization depth, or the number of levels between the president and the first-line supervisor; span, or the number of people reporting to each supervisory employee; whether there is overlapping responsibility or areas for which no one is responsible; and whether like functions are combined, or scattered throughout the organization.

Organizations are people. The key people in the organization should be appraised to determine their strong points, their weaknesses, and their present potentials. A carefully thought out plan of individual development should be prepared for each, so that each individual will ultimately be able to contribute his maximum to the organization. Strong organizations are made up of strong people, and to be assured of a continuing strong organization, there must be time, money, and leadership invested in the development of people for the future. Such development techniques as individual on-the-job coaching, company and industry

Abridged text of a District paper, DP55-302, presented at the AIEE Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955, and recommended for publication by the AIEE Committee on Management.

C. J. Beller is with the Cleveland Electric Illuminating Company, Cleveland, Ohio.

committee assignments, rotation of assignment, visits to other companies for specific purposes, night courses at local colleges, American Management Association seminars, and outside reading are some of the possibilities. In the case of engineers whose training has been limited to technical subjects, one of the streamlined management courses for executives offered by such schools as Harvard University, Columbia University, University of Pittsburgh, University of Michigan, and others might be very effective.

As part of future planning, future organization charts should be thought out to fit the changing needs of the business, and one or more (and three if possible) replacements should be developed for each future block on the chart. Current organization charts should be distributed so that each person knows exactly how he fits in the over-all picture.

With forecasts made, and the present and future organization planning taken care of, it is now possible to actually make plans for the future of the company. But these plans must be translated into concrete, tangible figures if specific use is to be made of them. This is done by budgeting. There are numerous types of budgets to suit individual needs but the most common cover capital additions, labor and other than labor expenses, income from sales, and cash requirements. From the latter it can be determined whether additional financing will be required, and if so, the amount. Some plans, of course, such as policies, cannot be reduced to figures, but they can and should be put in written form.

The budgets can be made for various periods in advance. Practically all organizations budget 1 year ahead. Some organizations also have less detailed budgets covering periods of 5 or 10 years in advance.

The budgets establish the pattern for future plans. In other words, they chart the course of the business. They furnish a bench mark so that actual performance can be checked against original plans. They are really advance estimates from which the future financial picture of the company can be developed.

Goals are often set in conjunction with budgets. The budget figures are set at a level almost sure to be realized with the present or expected levels of performance. Goals, on the other hand, are set at a level requiring substantial improvement in performance to be realized. The setting of goals offers a challenge to the organization. It is interesting that in many cases performance has been improved year after year by setting goals requiring increasingly good results.

After the budgets have been prepared in accordance with the established plans for the future, a timetable or schedule should be prepared. For instance, if the planning calls for a level of production 2 years hence which requires additional machine capacity and additional buildings, a construction schedule should be prepared showing the period during which the engineering and drawings for these additions should be processed, the time the contracts must be let, the time the major materials and equipment must be ordered, and of course, the time the entire project must be completed.

Such schedules serve a number of purposes. They indicate when construction expenditures will have to be made. They also indicate when additional manpower will be needed in cases where the construction is done by company personnel. But the most important advantage of a schedule is that it provides an over-all means of co-ordination between the various organizational elements involved. It also provides a means of checking progress on the various projects. The schedule is in effect the timetable of the company plan.

Before leaving the subject of planning, one important point should be emphasized. Planning is not the job of only a few people in top management. Each manager, each supervisor, and each specialist at all levels should be responsible for doing the planning within his area of jurisdiction. While some of the broad long-term planning must be done at the top, it is equally as important for the top executive to make sure that adequate planning is being done throughout the organization, and to co-ordinate this planning into an integrated over-all plan for the company.

CONTROL

THE SECOND major management function of the managing engineer is control. After the managing engineer has satisfied himself that the various components of planning have been properly taken care of in his organization, he must see to it that these plans are carried out. It is obvious that in an organization of any appreciable size, he will necessarily have to delegate to others the responsibility of carrying out the numerous parts of the over-all plans. He must, however, retain himself the ultimate responsibility for achieving the desired results.

In order to accomplish this, he will have to know at all times how each phase of the operation is progressing. If proper progress is not being made, he will have to take immediate action to correct the situation.

How can the managing engineer keep current on the many facets of activity for which he has top responsibility in the limited time available? How is he able to have a "feel" of the operation of the organization which reports to him? The answer is that he must use a carefully thought out plan of control so he will very quickly be able to appraise how each activity is progressing in relation to the original plans.

A simple definition of "control" in relation to the management of a business is, "Control is the process of determining that the assigned responsibility is executed according to plan."

However, the "exception" principle in control should be mentioned. Under the exception principle, those operations which are proceeding normally, according to plan, are not brought to the attention of the manager. Only those which deviate from the plan are called to his attention. This is on the basis that the manager need not spend his time on matters which are progressing according to plan; he had better use his time and energies on those functions which require "trouble shooting."

The following steps have been suggested as fundamental to controlling anything:

1. Selection of control points.
2. Definition of units of measure.
3. A systematic means for measuring and summarizing actual performance.

4. Selection of standards of performance.
5. Interpretation of the difference between actual performance and standard.
6. Decision on what action to take.
7. Action to comply with the decision.

While these might seem almost self-explanatory, a few examples in the engineering organization of an electrical utility will illustrate them.

One very simple illustration would be the kind of voltage supplied to the customers. This, of course, would be the control point. The unit of measure might be the number of justifiable voltage complaints per 10,000 customers per month. A monthly report of the voltage complaints would be the systematic means of summarizing the actual performance. The standard of performance would be the standard to which the systems were designed such as a range from 115 to 123 volts being considered as adequate service. If the number of deviations from this range as brought out by the voltage complaints was insignificant, the service would be interpreted as satisfactory. However, if there were suddenly numerous complaints in a certain area, the interpretation would be that there was a fundamental weakness in the distribution system. This would call for an engineering investigation and possibly capital investment would be required. While this is a very simple illustration, it points out the principle of control.

Another illustration is the cost of operating and maintaining substations. The unit of measure might be the cost per megawatt of peak system load over the last 12 months. This would be reported monthly by a system of functional reports. The standard of performance might be a comparison with the functional budget, or with past performance, or with a similar operation in other companies. If the variation from the standards chosen was appreciable, a study of the cause would be indicated. For instance, the cause might be indicated as too little use of automatic switching equipment, and the remedy would of course be to make use of more automatic equipment in the future or change existing facilities to automatic operation.

Another control point might be the progress on the construction schedule. The systematic means of summarizing this would be a monthly progress report on construction and the standard of performance would be the construction schedule.

Some of the broad controls used in industry are controls over policies, organization, wages and salaries, operating and maintenance costs, safety, capital expenditures, quality of service, advertising expenses, administrative expenses, and many more, depending upon the specific needs of the organization.

Control points should be selected with care. Too many controls are costly and are apt to direct attention from the areas requiring the most attention. Too few controls sometimes result in overlooking important areas by default. Each manager must make a careful analysis to determine the optimum controls to enable him to do the best possible job of managing.

The various policies of the company can be controlled by putting them in writing and distributing copies to the people who are responsible for administering the policy. From time to time, spot checks can be made to make sure the policy is being administered properly. It is very important to make certain everyone who has anything to do with the administration of policy really understands what the policy is. Unless policies are spelled out, there is a grave chance of error. Care must be taken, however, to make sure that policies which are written out are reviewed routinely to determine if changes are necessary to meet changing conditions.

Wages and salaries can be controlled by first establishing uniform principles and procedures to be followed in wage and salary administration, and then establishing routine reporting to indicate the results of the application of these principles and procedures.

There are many ways which have been used to control costs. There is a whole area of accounting dealing with this subject called "cost accounting." One method to control costs is to determine what "standard costs" are for various units of work, and to show deviations from these standard costs on routine reports. The standard cost is the cost of doing an element of work in the most efficient manner by high-grade workmen. Another control of costs is a comparison with costs in previous years, or, if available, with the costs of the same operation in other companies in the industry.

Organizations can be controlled by giving attention to the number of levels from president to first-line supervision, number of people reporting to each supervisor or executive, grouping similar functions, avoiding overlapping responsibilities and areas for which no one is responsible. A system of appraising key people and classifying them in such categories as immediately promotable, satisfactory in present job but not promotable, barely satisfactory, and inadequate is not only helpful in keeping the organization in control, but points out areas where constructive work must be done to assure a good organization in the future.

APPRAISAL OF PERFORMANCE

Now consider the third major function of the engineering-manager, the appraisal of performance. The next step is to analyze the deviations from the original plan, as indicated by the system of controls, and then make an appraisal of how these deviations affect the business, and what action, if any, is necessary.

It must be borne in mind that no plan is rigid and inflexible. Almost certainly as conditions change from the original assumptions, plans must be changed accordingly. Quite often the deviations of the actual operation from the original plan are due to these changes in conditions, and the deviation is found to be not only justified, but necessary or proper.

An example in the electrical utility industry will be helpful. A schedule for electrical construction work by company crews was laid out on the basis that they could start work on a major plant job on a certain date. Due to a delay in construction of the building by an outside contractor, it was not possible for the electrical construction crews to start the job until nearly 3 months later. This resulted in not only rescheduling the work at the plant, but compensat-

ing adjustments had to be made for electrical construction work at a large number of substations as well. It resulted finally in a wholesale rescheduling of the entire company construction program. Such upsets are almost the rule, rather than the exception. The important point is that plans should be kept sufficiently fluid so that changes can be made quickly to accommodate changing conditions.

In appraising performance, it is well to consider these four items:

1. What was the job to be done?
2. How was the job done?
3. How well was the job done?
4. Could it have been done better?

The manner in which the appraisal of performance is carried out will vary according to the needs of the particular company. The procedures should be set up to obtain the best over-all results.

For example, in one company, a very effective procedure for reviewing performance has been set up. Every Fall each supervisor, manager, and vice-president presents to a superior a "Budget Planning Report," which reviews the progress during the year on items covered in the previous budget planning report, and spells out the plans for the coming year.

The types of items reviewed in the report to show progress during the year are:

1. Performance goals.
2. Performance measures and standards to be installed, or improved.
3. Procedure and method changes.
4. Training and development.
5. Organization changes.
6. Mechanization and work simplification.
7. Safety.
8. Other objectives.
9. Additional accomplishments.
10. Employee man-hour and other-than-labor requirements.
11. Capital additions requirements.
12. Status of planning projects.

Also covered are plans, forecasts, and estimates in these same general areas for the following year.

Each department head is given the opportunity to discuss his report with the vice-president of his group and the executive vice-president and president.

This method gives the head of each department the feeling he is accountable for the operations of his department, and that his effectiveness will be measured by the results he has produced. His level of remuneration is based to a large extent on his monthly performance analysis reports and his year end future planning reports.

During the review of these reports, any possible corrective action which has not yet been taken is considered. This may range from specific steps to develop key people to changes in broad company policy. What is important is to bring weak spots out in the open and focus attention on them.

Mere statements of factual data in performance and planning reports are not enough. The interpretation of the factual data to show its ultimate effect on the business is most important. Comparisons with standards, goals, past performances, budgets, and the comparable figures of other companies in the industry are useful in the interpretation of data. These establish bench marks by which it can be told whether the present performance is excellent, average, or poor.

Another technique is to have each supervisor, department head, and vice-president submit to his superior each month a "Performance Analysis Report" covering in general the following eight areas:

1. Personnel.
2. Work load.
3. Productivity.
4. Safety.
5. Expense.
6. Quality.
7. Work simplification, mechanization, and standardization.
8. Future planning.

In these reports, the "exception principle" is stressed. In other words, the trouble spots are brought out in the open, so that appropriate action can be taken before the situation has deteriorated.

CONCLUSION

To SUMMARIZE, it has been pointed out that managers of engineering organizations need to apply the principles, skills, and techniques of management if they are in reality to do a good job of management. They need to plan ahead, both long term and short term. To plan ahead, they need a proper present organization, and they must tailor their future organization to their future plans. The objectives toward which they are working must be clearly understood. The business climate for the period for which the planning is being done must be forecasted as accurately as possible. Then the actual plans must be formalized in budgets, schedules, and policies.

Next, the operation must be properly controlled, so that the enterprise runs according to plan. Proper control points must be established, and major deviations must be brought to light.

Then the results of the operation must be routinely appraised to determine the quality of performance throughout the enterprise; whether the operation is in effect following the plans and accomplishing the predetermined objectives. And finally, any necessary corrective action must be put into effect.

The field of management of engineering-type organizations offers great opportunities for those who are properly qualified. It is a natural objective for engineers who have reached a high degree of engineering competence, and have the aptitude and desire to enter the management field. The rewards are commensurate with the high qualifications which are required.

REFERENCE

1. Top Management Organization and Control (book), P. E. Holden, L. S. Fish, H. L. Smith.

Solar Energy

FARRINGTON DANIELS

Solar energy can now compete with animal power and manpower, but there will be no era of solar prosperity in the near future. With the coming shortages in fuel supply, however, extensive programs of research and development on the utilization of solar energy should not be delayed.

ALL COAL, GAS, AND OIL were produced by sunlight through photosynthesis millions of years ago and preserved for use by geological accidents. These reserves are being used up at a rapid rate. They will not last forever. Natural gas will give out first, then petroleum, and finally coal. As long as coal is available, the chemist can give us gas and oil. Some European countries are already feeling the pinch of dwindling fuel supplies.

Electricity and cheap power is becoming more and more of a necessity, and every decade makes a return to the horse and buggy days more unthinkable.

Factors tending to shorten the life of the world's limited fuel resources are: a rapidly increasing population, increasing demands for energy and a higher standard of living, and the industrialization of countries which are not now industrialized.

What is to be done now? Ration our coal and oil and gas so that future generations may be assured of an adequate supply? Not yet. A more pleasant solution and the most constructive approach to the problem lies in intensive research for substitute energy sources—chiefly atomic energy and solar energy. This responsibility cannot be delayed.

There is a second impelling reason for stressing immediate development of atomic and solar energy. Much of the world lives on human labor and the work of animals. Recently a world conference was held in India on Solar Energy and Wind Power—the purpose of which was to study the possibility of raising living standards, particularly in arid regions through the use of sunlight and wind. Time was when the United States could ignore the rest of the world in complacent isolation protected by two oceans. Those times are gone forever with the improvements in communication and travel. Now there is intense competition for the good will of all nations, and so there is on our part not only a humanitarian desire, but also a selfish motive, to help the nonindustrialized nations attain a higher standard of living. Atomic and solar energy should not be thought of as competing now with coal and petroleum in the United States, but with manpower and animal power in Asia, Africa, and South America. This is a much easier competition. Terms of kwhr per dollar of investment and per ton-mile of transportation should be thought of rather than terms of kwhr per pound of coal or per gallon of gasoline. The problem facing future generations need not be waited for, as there is a vital problem right now.

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FUEL SUBSTITUTES

WHAT are the relative chances of atomic energy and solar energy in their competition as a fuel substitute. Both are important, and each will move forward rapidly. The atomic energy will come in large expensive units as central power stations, while solar energy will come in small inexpensive units in rural areas. Atomic energy will come first because billions of dollars have been invested in it, while almost no support has gone into solar-energy research, Fortunately, solar-energy development is not handicapped by military needs and secrecy.

But solar energy is getting started. A symposium on the utilization of solar energy, supported by the National Science Foundation, was held at the University of Wisconsin, Madison, Wis., a year ago. A book, "Solar Energy Research," based on this power symposium was published in May. Reference has also been given to the fine conference last October sponsored by the Indian Government and United Nations Educational, Scientific, and Cultural Organizations (UNESCO). Another world-wide conference on solar energy is scheduled for Arizona in November.

Our sun's energy will be here as long as there are people on the earth to use it. But will there be enough? Yes, there is enough heat energy and it is cheap, but it is expensive to use for power. Atomic energy is too intense and its radioactivity is a handicap. Solar energy is too diffuse, and expensive devices are needed for raising its temperature. But combustion fuel is just right (because engines have been designed for it) and it is being used up as fast as possible.

How much solar energy is present? Five hundred kilocalories per square foot per day is a rough estimate in sunny areas. The average American person consumes food for himself at the rate of 3,000 kilocalories per day, but he consumes fuel for his machines at the rate of 150,000 kilocalories per day. Perhaps kwhr is more familiar than calories. One kwhr of heat (costing 1/2 to 2 cents) is equivalent to 860 kilocalories. This would be equivalent in energy to a skimpy meal or theoretically to something less than 2 square feet of solar energy for a day.

Going to a larger unit, consider 1,000 square feet as the area of a suburban house. It would receive something less than 500,000 kilocalories of sunlight per day—600 kwhr of heat, 150 kwhr of electricity at a 25-per-cent efficiency, or about 6 kw calculated on the basis of a 24-hour day. This is a challenge worth working for, but it is a difficult one. There is no solar engine or other device that can approach the 25-per-cent efficiency for the conversion of heat into power or into electricity. A device for even a 5-per-cent efficiency of conversion, giving about a kw of electricity, is prohibitively expensive now in competition with combustion fuel. But these optimistic figures show that attention should be turned toward research on solar energy.

SOLAR ENGINES

THERE are three types of solar engines: focusing; flat plate; and intermittent.

The focussing type has been used already. In the 1880's in Paris, a parabolic mirror focussed sunlight onto a water boiler and ran a steam engine which operated a printing press. In 1913 a 20-hp solar engine pumped water from the Nile for irrigation near Cairo. For two decades in New Mexico a solar engine pumped water to a reservoir tower and operated a water wheel and dynamo to light a small mine day and night. Dr. Abbott has built working models and has a design for a 2-hp solar engine ready for production. It has a boiler for a high-boiling liquid made of an evacuated double-walled pyrex tube. Small solar engines are pumping water in India.

Solar engines are expensive. The parabolic mirrors are large and costly and they are mounted with motors to follow the sun. On a large scale they are subject to wind damage. Parabolic cylindrical mirrors tilted at the correct angle are simpler. A new hope lies in the use of aluminumized plastics, which have good reflecting surfaces obtainable for only a few cents a square foot.

In the flat-plate collector type the expensive moving reflector is replaced by glass plates, which act as glass in a greenhouse. They are transparent to solar light and heat, but opaque to the infrared heat radiated from the boiler. They act as solar heat traps, and four glass plates seem to be an optimum.

The intermittent type involves the expansion and contraction of a light-absorbing gas by alternate exposure to sunlight and shadow.

The problem is to develop a high temperature so as to make good use of the formula $(T_2 - T_1)/T_2$, but because the efficiency is bound to be low the area must be large and the cost of materials per square foot low.

There is a great demand for a cheap solar engine to compete with animal power and manpower. The delegates to the solar conference in India were impressed in seeing four bullocks and two men working diligently and skillfully to irrigate a farm—but the whole group was doing work equivalent to a third of a horsepower. A solar collector and engine covering the area on which the bullocks walked would give 1 horsepower even if the solar engine had an efficiency of only 1 per cent. To solve these problems for our friends in other parts of the world, let's forget our professional pride and try to devise solar engines not with 20- to 35-per-cent conversion of heat into work, but with only 5- to 10-per-cent conversion. Remember that the fuel is free but do not forget that the capital investment must be low, and the repair and maintenance problems simple.

STORAGE OF POWER

THEN there is the problem of storage of power. Solar engines do not operate after the sun sets. Mechanical storage with reservoirs and weights is impractical, and heat storage is difficult at the temperatures needed. Certainly the challenge for chemical or electrical storage is impelling. A storage battery is needed along with a solar engine. The battery does not have to be small nor portable, as in the case of an automobile battery, and it need not deliver very large current. The electrolysis of water and storage of hydrogen and oxygen, and the electrodeposition of aluminum for primary batteries are among the possibilities which should be explored.

HOUSE HEATING

HOUSE HEATING is a much simpler problem than power because the temperatures are lower. A report to President Truman predicted a market for 13 million solar-heated houses in the United States by 1975, mostly in the southern half of the United States. There are only about three now. There are two problems: collecting, and storing the heat.

One type uses hot water with large storage tanks. Here the problem is to reduce the heat losses from the storage tank. A second type stores the heat in pebble beds, perhaps gravel or crushed rock with pieces about 1 inch in diameter, enclosed in a sunken garage. A third type uses a chemical transition such as the hydration of sodium sulfate at 91 F. The gravel beds are the cheapest to construct. The chemical storage is the most efficient and the most expensive. Sodium sulfate is a cheap chemical, but large quantities are required and there are problems of corrosion and nucleation and rate of crystallization. Dr. Maria Telkes built a house with 800 square feet of glass-window exposure, the heat being stored in drums of sodium sulfate between the walls of the house. It had capacity for ten cloudy days, and it went through three winters in Massachusetts. Houses in cold climates should probably have auxiliary fuel heaters for use in particularly cold weather or in a succession of cloudy days. The saving in fuel should offset the cost of solar heater.

There are problems in the collectors also. Glass-covered shallow trays, black pipes, and plastic tubes and channels, all deserve serious research effort. The collectors are of large size and they present problems in architecture for the designer of attractive suburban homes. Solar heating of large apartment houses in crowded cities does not seem to be hopeful. Here again early developments in solar energy may well come in the nonindustrialized countries. A letter from Mexico pleads for help in a village where the women walk 6 miles to the hills for their firewood for heating and cooking and carry it on their backs. And there is ample sunlight all around. Can something be done to help? Perhaps, if collectors of cheap, lightweight, and transport-

able plastic films can be devised. Storage of heat, too, must be arranged in the simplest cheapest manner.

REFRIGERATION

REFRIGERATION in the Orient is more important than house heating. A simple inexpensive solar refrigerator could do much to improve nutrition in areas where electricity is not available. Research might well be directed toward a type of refrigeration in small units in which low-boiling liquids are vaporized with solar heat and condensed with air cooling. Standard units could be operated by solar engines. At the solar-energy conference in India, Prof. V. Baum of the United States of Soviet Russia reported the operation of a solar engine and refrigerating plant that produces a quarter of a ton of ice per day. Air conditioning of houses is a more ambitious program than the refrigeration of food. Here again is a challenge to develop a simple type of cooling through evaporation with the sun's heat. Many of these problems of the utilization of solar energy are interrelated. An inexpensive collector of solar energy, possibly one which makes use of thin plastics, can be used for a variety of purposes—heating, cooling, cooking, and operation of engines. In connection with house heating and cooling, one immediately thinks of heat pumps. The development of a suitable heat storage unit, perhaps with thermostating chemicals, could be used in the operation of a heat pump. In some areas of the United States, the peak electrical loads used to come in the wintertime, and now there is perhaps a tendency in southern areas for the peak loads to come on hot days in the summertime. Hot days are usually associated with intense sunlight. Any practical development leading to storage of heat, operation of heat pumps, and house cooling might reduce the peak loads in the summertime through the partial utilization of solar energy.

COOKING

SOLAR COOKING has been promoted in India where the present fuel for cooking is cow or camel dung. This material ought to be used for fertilizer instead of fuel. A solar cooker has been developed with a parabolic metallic mirror which is equivalent to a 350-watt hotplate, and it sells in India for $14. This is too high a price for general introduction and it was generally agreed at the conference that the price would have to come down to about $5 before solar cookers would be accepted. Of course, solar cooking cannot compete with cooking by gas and electricity, but there are many areas where solar cookers could save valuable grass and shrubs and wood, and lead to a conservation of the soil. It is hoped to develop a semiparabolic balloon with a thin plastic, aluminized on the parabolic surface. Experiments at the University of Wisconsin laboratory with Dr. John A. Duffie indicate that this may be a possible approach.

DISTILLATION OF SEA WATER

DISTILLATION of sea water offers important possibilities for utilizing solar energy. Wooden troughs filled with salt water and covered with inclined plates of glass have been successfully used for many years in the preparation of fresh water from salt water. The capital investment of these solar stills is so high that competion with irrigation water is difficult. In some areas, however, premium prices for fresh water can justify solar distillation of salt water. Again, the use of plastics may lead to a more economic type of still. Experiments were carried out at the university laboratory with plastic tubes 12 feet long and 4 inches wide. These tubes were three-quarters filled with blackened salt water and surrounded by a still larger plastic tube to cut down heat losses. In Madison, Wis., it was possible to obtain a temperature of 57 C on sunny days. Air was blown over this heated water, and fresh water was obtained in a standard condenser, cooled by the incoming salt water. With this arrangement, a 25-per-cent efficiency in the solar distillation of salt water was obtained. Experiments will be continued to ascertain how long these plastic tubes will withstand weathering conditions and bright sunlight.

SOLAR RESEARCH

ALTHOUGH sunlight is too cold for efficient use in solar engines, it is perhaps surprising to find that solar energy is being used for research at very high temperatures. Large and perfect parabolic mirrors can produce temperatures of over 5,000 F in small areas. In this way, important tests of materials are being carried out. Prof. Trombe of France is carrying out research with a 30-foot parabolic mirror.

The long-range hope for the utilization of solar energy lies in photochemistry and in photoelectricity. An endothermic photochemical reaction is needed in which products produced by sunlight can be stored and used later to supply the energy absorbed from the sunlight. The task is difficult, but nature's photosynthesis which has been going on for millions of years gives hope that solar energy may be used more directly than through the medium of agriculture. The Bell Telephone Laboratories developed a photo semiconductor of silicon which gives promise for the direct conversion of sunlight into electricity, and further developments along these lines can be looked to with interest.

THE FUTURE

THERE is no new era of solar prosperity just around the corner. It will be a long time before solar energy can compete with combustion fuel and electricity, but it can compete right now with animal and manpower. It is due those in the nonindustrialized countries and to future generations to start now an extensive program of research and development on the utilization of solar energy.

There should be no worry about energy resources. The future can be faced with confidence if the world's population problems and its political ills can be controlled. Atomic energy from nuclear fission can come rapidly, followed soon by solar energy, and there is also a very remote chance of learning how to control and use the energy of fusion of light nuclei, such as in the transformation of hydrogen into helium. Future fuels shortage should be taken seriously, but there is no need to be frightened by it. Continuation of civilization into the future depends on the vigor of research, on the wisdom of statesmen, and on the common sense and education of people.

Satellite- and Booster-Station Allocation Developments

OSCAR REED, JR.

With the growth of television broadcasting service, and especially its application in the uhf field, the "shadow" areas that have no coverage have become more apparent. As a result, the FCC has authorized the operation of satellite and booster stations to increase the availability of television service to the whole country.

IN THE BROADCASTING INDUSTRY the delivery of a program to the public depends, among other things, upon two factors. One of these is the signal strength of the program at the receiver. The other is the amount of noise, or undesired signal present, which may interfere with the reception of the program. Therefore, both the absolute strength of the broadcast signal present and the noise and interference conditions which prevail must usually be considered or, in technical language, it is the ratio of desired to undesired signal. Standards of the Federal Communications Commission (FCC) define the minimum acceptable ratios which must prevail in the various services, if satisfactory program reception is to take place. In the standard broadcast field the desired signal must exceed the undesired signal or noise on the same channel by a minimum of 20-to-1, if acceptable service is to be rendered. In the FM field the required ratio is 10-to-1. In the television field, while no standard is set, a ratio of 40-to-1 represents a practical requirement.

The broadcaster is interested in as great a coverage area and the delivery of as much service to his public as possible. Attention is therefore frequently directed toward the periphery of the coverage area. Sometimes it is turned to other cities of fairly large size in what is considered to be the middle range of the coverage radius. In such areas the noise from static or man-made contrivances may be so great as to prohibit obtaining the required signal ratio of desired to undesired components. This, of course, leads to several standards of service in the broadcast field and a consideration of the required strength of the desired signals in cities of various sizes. The coverage area of any station may be viewed as a piece of swiss cheese in which the holes represent areas where the desired signal will not be sufficiently strong to overcome the undesirable components present.

AUXILIARY STATIONS

THESE FACTORS have for years led the industry and the FCC to consider the use of auxiliary stations spotted in these "holes." These auxiliary stations would rebroadcast the programs of the parent station on either the same or different frequencies. Because of crowding in the standard broadcast band, it has not been possible to consider operation of the retransmitting station on a different frequency, and investigations have been carried on using "booster" stations on the same channel. In some respects, however, the establishment of a booster station is not an unmixed blessing. It is capable of causing interference to the parent station in areas where the required ratios as outlined do not prevail. Attempts have been made to minimize this self-interference by synchronizing the parent and the booster station. By synchronizing the two stations, the required ratio of desired to undesired signals for satisfactory service can be substantially reduced, and the self-interference minimized.

With the establishment of the television broadcast service and particularly its application in the higher uhf range, the holes in the service area became much more prominent and apparent. This is frequently caused by terrain or man-made obstacle difficulties, where the signal from the main station drops far below the value required for service to the town or city. In addition to this, with the present economics of the television broadcast structure, the Commission has recognized that there may be towns of fairly good size which may not be capable of supporting their own television stations. Accordingly, on August 5, 1954 the Commission gave Public Notice that it would consider applications for uhf stations which would not originate local programs but would duplicate the programs of another television station. The auxiliary station would thereby extend the service of the parent station. They also indicated that such a station while acting as a "satellite" would be considered as an operating television station and would use the channel assigned to the particular community in which it operated. The Commission indicated that it would even consider such program duplication by stations under common control.

In its Annual Report for fiscal year 1954, the FCC announced that it had under consideration the authorization of "booster" or "satellite" television stations. These stations which would operate with low power and low antenna height would be supplemental stations which could be used to extend coverage in "shadow" areas. They indicated that operation could be on the same channel as that of the main station, or on a different channel. The term "booster" station has been applied to a small low-power supplementary station which operates on the same

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channel as the main transmitter. The term "satellite" station has come to be applied to a station which operates on a different channel, usually one of those contained in the Commission's Table of Assignments for the television service.

The FCC in its Annual Report also indicated that it had continued to deny requests for experimental authority to operate television boosters and satellites intended to sound out public reaction. The reason given was that the technical aspects of this type of operation had not been fully determined and there could be no assurance such a service, once started, would continue. It was feared that by providing a temporary improvement to television reception in certain areas, such stations might encourage substantial investments in television receivers which would become useless if and when the experimental operations were terminated. In a sense, the pronouncement of August 5, 1954, while not proposed as a change in the rules of the FCC represented an easement in this philosophy.

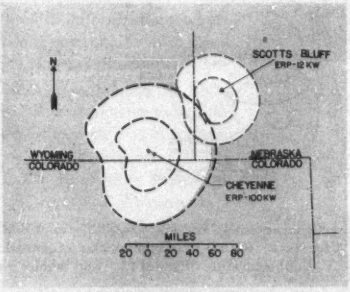
DISTRIBUTION OF SERVICE

AN EXAMPLE of the thinking at the FCC, developing in the Fall of 1954, is interesting. The following excerpts are from a paper on "Television Satellite Systems," delivered by Curtis B. Plummer, Chief of the Commission's Broadcast Bureau at the Fourth Annual Broadcast Symposium of the Institute of Radio Engineers' Professional Group on Broadcast Transmission Systems in Cleveland, Ohio, on September 25, 1954. In his paper, Mr. Plummer referred to a philosophy developed earlier at the FCC. This indicated a desire to distribute television channels geographically in such a manner that the various services would be distributed over the country two or more times. It was recognized that in order to achieve this it becomes necessary to have television stations in many small towns and cities. He then went on to indicate that this requirement runs into economic difficulties. He then stated: "Therefore, as an over-all allocation objective it might be said that we have the following priorities of considerations: (1) All of the area of the United States should be covered at least once with television signals. (2) All of the United States should be covered as many more times as possible. (3) We should allow as many people as possible to get into the business of television broadcasting, and especially in the larger cities where the economics would probably support more than one or two stations. The problem, therefore, is primarily fitting the economics of television broadcasting to the technical and propagation situation so that we may get the greatest area coverage."

The concluding paragraph in Mr. Plummer's talk is also of considerable interest and, in fact, forecasted developments late in 1954 and early this year. It was as follows: "The FCC did not adopt any of these plans specifically (stratovision or polycasting), but adopted a rather broad basic plan using reasonably sized ground based stations somewhat in line with the standard broadcast policy. Ample station separations and flexibility in height and power were allowed so that area coverage might be achieved by having a service area of somewhere between 40- and 70-mile radius for each television station. This plan is such that it sets up the basic allocation system to control distribution of stations and interference between stations. It is entirely appropriate to build on the system adopted by the FCC in at least two ways. First, assume that in small towns some method is used whereby more economical operation of television stations can be achieved. The Commission has already proposed to waive any requirement for local programming and thereby allow multiple programming over several transmitters. Second, it appears possible to use any assignment made in the allocation table with multiple transmitters to cover the same area rather than a single large transmitter. It now appears that we are at the place in the development of the television broadcast service where the development of the multiple transmitter idea is appropriate."

The next important formal announcement on this subject by the FCC occurred December 17, 1954. This took the form of Notice of Proposed Rule-Making in Docket No. 11237, which looked toward the authorization of operation of low-power television broadcast stations. In the introductory paragraph the Commission referred to its earlier notice of August 5, 1954, which related to uhf stations. The Commission then indicated it had recently authorized the operation of a vhf station in Lufkin, Tex., which did not propose to originate local programs. It was contemplated under this authorization that the programs of a Houston, Tex., station would be rebroadcasted.

In this Notice of Proposed Rule-Making, the Commission indicated that perhaps its minimum power requirement then contained in the rules was too high to stimulate the type of extension of programming envisioned. The rule



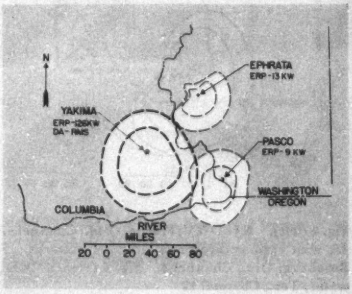


Fig. 1 (right). KFBC-TV, Cheyenne, Wyo., Channel 5; and wholly owned satellite KSTF-TV, Scotts Bluff, Nebr., Channel 10. Fig. 2 (far right). KIMA-TV, Yakima, Wash., Channel 29, directional antenna; uhf satellites KEPR-TV, Pasco, Wash., Channel 19, and KBAS-TV, Ephrata, Wash., Channel 43

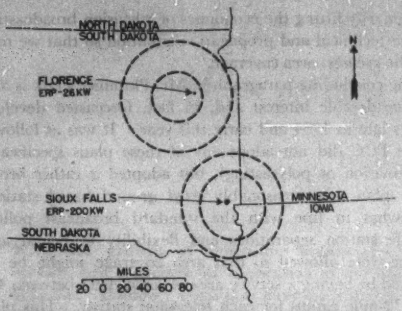


Fig. 3. KELO-TV, Sioux Falls, S. D., Channel 11; and wholly owned satellite KDLO-TV, Florence, S. D., Channel 3

then in effect contemplated that the minimum visual effective radiated power would be 1,000 watts at a minimum effective antenna height of 300 feet for cities under 50,000 population. The new proposal reduced this requirement to a minimum visual effective radiated power of 100 watts for cities under 50,000 population, and eliminated entirely the criterion as to antenna height. In connection with this release, the Commission also asked for comments on a number of technical and nontechnical questions. Among the nontechnical questions was one inquiring whether rules relating to multiple ownership of television broadcast stations should apply to the new low-power stations contemplated. Comments on this proposal were filed by April, 1955. Many of those replying to this notice submitted favorable comments on the assumption that the Commission would permit vhf "drop-ins" under low power and less than minimum antenna height and mileage separation requirements. The Commission has since pointed out that this assumption was erroneous.

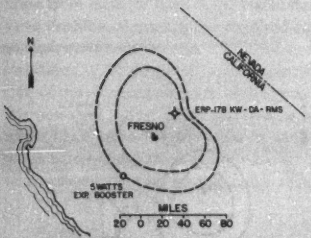
Effective August 1, 1955 the Commission adopted the low power proposal, reducing the minimum required visual effective radiated power to 100 watts and eliminating entirely the criteria as to minimum combinations of power and antenna height for cities of various size. Necessary combinations of height and power will be influenced in the future only by those provisions of the Standards which relate to minimum signal requirements over the city limits of the community to be served and the new 100-watt specification.

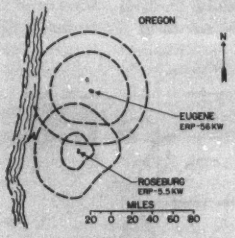
SATELLITE STATIONS

THE FCC has, under its pronouncement of August, 1954, authorized several satellite operations which indicate a trend. One of these is KSTF, Scotts Bluff, Nebr., which was to commence operation in July, 1955. Fig. 1 shows the parent station and the proposed satellite indicating the respective Grade A and Grade B theoretical contours. The satellite station has been authorized to operate on Channel 10, the assigned Scotts Bluff channel. It duplicates in its entirety the programs of KFBC-TV in Cheyenne, Wyo., which operates on Channel 5. The Cheyenne station carries all the television networks, and the ownership of the two stations is identical. The proposed transmitter sites are approximately 90 miles apart. The rate card shows the common ownership and applies a combination rate to the two operations indicating simultaneous telecasts.

During the week of April 11, the Commission also authorized a satellite of KIMA, Yakima, Wash., to operate in Pasco, Wash. The Yakima station is assigned Channel 29 and the channel for the proposed satellite is Channel 19. The visual effective radiated power for each station is of the order of 10 kw. Later in the year the FCC authorized a second satellite to be located in Ephrata. Fig. 2 shows the Grade A and Grade B coverage limit contours for this combined operation. The grant of the Ephrata satellite, which was made without a hearing, was recently protested by KSEM, Inc., operator of a radio station in Moses Lake, Wash., approximately 18 miles from Ephrata. This protest has been scheduled for hearing by the FCC.

As a further example, during the week of April 4, the Hills Broadcasting Company of Florence, S. D., was authorized a station to operate as a "part-time" satellite on Channel 3. It will rebroadcast some of the programs of KELO in Sioux Falls, S. D. Fig. 3 shows the proposed theoretical contours. It will be noted that the Florence satellite operating on Channel 3 has an indicated coverage potential as great as or slightly greater than the parent station. KELO is the sole owner of the new Florence





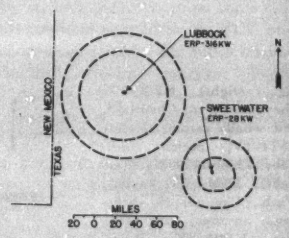


Fig. 4 (left). KJEO-TV, Fresno, Calif., Channel 47, directional antenna; and experimental booster KM2XGZ, Coalinga, Calif., Channel 47, with various directional antenna patterns. Fig. 5 (center). KVAL-TV, Eugene, Ore., Channel 13; and half-owned satellite in Roseburg, Ore., Channel 4. Fig. 6 (right). KDUB-TV, Lubbock, Tex., Channel 13; and wholly owned satellite KPAR-TV, Sweetwater, Tex., Channel 12

station which will operate with an effective radiated power of approximately 26 kw at an antenna height of 710 feet.

The authorizations noted in the foregoing confirm that whereas the booster type of station will be of relatively low power and used to raise the signal strength in a given community, the satellite type of station will be authorized on other regularly assigned channels. The latter type station will be installed consistent with the minimum power requirement of the rules and as influenced by the size of the community which determines the necessary extent of the minimum city service signal. It may also be concluded that, in general, satellites are being authorized at distances beyond the normal service area of the parent station and may function as either full-time or part-time satellites. It is important to recognize that these actions have been taken under cognizance of a public notice of intentions rather than the rules of the Commission. Therefore, many of the questions on which the Commission has requested information, in connection with its public announcement and proposed rule-making matter, still remain to be resolved. It is evident, however, that the Commission is feeling its way forward in this situation.

On March 31, 1955, the Commission invited industry views on television "booster" operation to fill gaps in normal uhf service areas. This document gives a good deal of the background thinking and contains questions which the Commission is considering. They are asking for industry's help in connection with these problems. There is some opinion to the effect this step, which is in the form of a proposed rule-making proceeding, may ultimately be related to vhf operations as well. In the Public Notice of this proceeding the FCC coined another term. It introduced the designation "amplifying transmitter" in its search for a solution to the problem of service to all the population of the United States. The experience of WSM-TV of Nashville, Tenn., with a vhf operation of this sort in Lawrenceburg (67 miles from Nashville) is touched upon in the notice. Reports concerning these latter experiments are contained in current technical literature.

Fig. 4 shows the location of an experimental booster operation authorized for KJEO in Fresno, Calif. The main station and the booster station will both operate on Channel 47. The antenna will be of the corner reflector type oriented for horizontal polarization and mounted on a 30-foot wooden support pole. The authorization contemplates that the directive pattern may be changed approximately 15° in either the vertical or horizontal plane.

There are four additional satellite authorizations which are of interest because of the various types of allocation situations which they exemplify. Fig. 5 shows theoretical Grade A and Grade B limits for station KVAL-TV, Eugene, Ore., operating on Channel 13. Similar contours are shown for its Channel 4 satellite, which will be located near Roseburg, Ore. This satellite is presently in construction-permit status. The licensee of KVAL-TV owns about half of the satellite. In this case theoretical overlap of the contours is indicated with the Grade B contour of the satellite station overlapping the Grade A contour of the parent station.

Fig. 6 shows Grade A and Grade B limits of KDUB-TV in Lubbock, Tex., operating on Channel 13. Also shown are the theoretical limits of its wholly owned satellite, KPAR-TV, which is presently being constructed. KPAR-TV will operate on Channel 12. It will be noted that there is no overlap between the two operations and that the theoretical coverage of the parent station is considerably greater than that of the satellite.

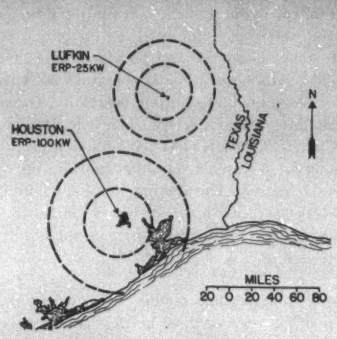


Fig. 7. KPRC-TV, Houston, Tex., Channel 2; and part-time independently owned satellite KTRE-TV, Lufkin, Tex., Channel 9

Fig. 7 shows the Grade A and Grade B limits of station KPRC-TV Houston, Tex., operating on Channel 2. Contours are also shown for station KTRE-TV, Lufkin, Tex., which will operate on Channel 9. This station proposes to rebroadcast some of the programs of KPRC-TV and it is presently in construction-permit status. The fact that these two stations are independently owned makes this the only authorized satellite operation to date which is not at least partially owned by the parent station. It is also interesting to note that the owners of KTRE-TV once held a construction permit for independent operation on Channel 9 in Lufkin. This construction permit was subsequently

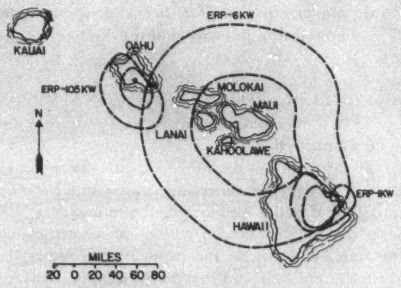


Fig. 8. KGMB-TV, Honolulu, Oahu, Channel 9 (upper left); and wholly owned satellites KMAU, Wailuku, Maui, Channel 3 (center), and KHBC-TV, Hilo, Hawaii, Channel 9 (lower right)

dropped for economic reasons. Again it will be noted that there is no overlap of contours.

Fig. 8 shows Grade A and Grade B limits for station KGMB-TV, Honolulu, Oahu, operating on Channel 9. The same theoretical limits are indicated for its two wholly owned satellites, stations KHBC-TV, Hilo, Hawaii, operating on Channel 9 and KMAU, Wailuku, Maui, operating on Channel 3. The main station is shown in the upper left corner of the figure. The greater extent of the limits shown for the Maui operation in the center of the figure is caused by the great height of the transmitter on the island crater.

CONCLUSIONS

Based on the foregoing factors, it is evident that Commission policy as regards these matters is in a state of flux. The situation is subject to change and there is reason to expect that the Commission will adopt any reasonable procedures in order to increase the availability of television service to the whole population of the country. Based on past experimental operations, there is some rudimentary knowledge available on engineering factors. It should be emphasized, however, that each case in question must be carefully explored and engineered. This indicates that equipment-package cost figures being speculated about, ranging from 15 to several-hundred-thousand dollars, must in each instance be examined in the light of particular requirements and the particular local situation.

It is evident that the FCC is looking for ways and means to fill "holes" in service areas with boosters or amplifying transmitters. They are also extending service on an area basis to communities and surrounding regions by means of satellite operations where there appears to be little likelihood for the foreseeable future that independent television programming service will be afforded because of present economic road blocks. While the Commission has given some evidence of frowning on the "drop-in" procedure for low-power operations, there is every reason to believe that they would consider the usual assignment table rule-making request "drop-in" where satellite type of operation could then result. Just where the Commission's concern for multiple ownership would leave off and their desire for more service to the population of the country would take over, may well be a matter for exploration under each combination of circumstances involved.

Modernizing Service Controls on Rapid Transit

GEORGE KRAMBLES

Many varied professional skills have gone into the development of this rapid-transit control system to obtain a balance between economy and passenger convenience. Modern methods are used for despatching trains, for recording train movements, and for direct communication to operating personnel and passengers.

EVER-INCREASING TRAFFIC CONGESTION has directed renewed interest in rapid-transit railroads as the most effective means for bringing large numbers of people swiftly across the broad expanse of modern urban areas. However, the staggering capital outlays required for this kind of facility demand that automation be applied to keep the price of service within range of the market. Fortunately, these same mechanical and electrical aids produce an improved control over the quality of the service offered.

"Line supervision" is a collective term for new methods developed by the Chicago Transit Authority (CTA) to provide evenly spaced and equally loaded rapid-transit trains, so to maintain service according to schedule, to restore service following any delays, and to increase the capacity of the system.

About $125,000 has been invested in line supervision, from which there have been obtained savings in rolling stock, manpower, and operating costs, which easily return the entire investment in 1 year. For example, it is estimated that at least 28 to 30 additional cars, worth nearly $1.5-million at today's prices, are saved though ability to fit capacity more closely to demand; and by reductions in running time and recovery time allowed to terminals to protect return service against delays. Brief consideration of the background of the problem may help bring out this point.

Revised text of paper 55-565, "Modernizing Service Controls on Rapid Transit," approved by the AIEE Committee on Land Transportation and recommended by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Scheduled for publication in AIEE *Applications and Industry*, 1955.

George Krambles is with the Chicago Transit Authority, Chicago, Ill.

Planning of the Chicago Transit Authority's project was directed by L. M. Traiser, staff engineer, while engineering and installation of the work was under the supervision of C. A. Butts, signal engineer, and W. C. Janssen, electrical design engineer. Techniques of application were developed under the supervision of J. F. Higgins, assistant superintendent of rapid-transit operation.

BACKGROUND OF THE PROBLEM

RAPID TRANSIT SCHEDULES are designed on the basis of the number of passengers requiring service in each 15-minute period of the day and night. Headways between trains and number of cars per train are varied to obtain a balance between economy and passenger convenience that yields the maximum over-all benefit. Although service demands change throughout the day, the transition is gradual and there are long periods of practically constant headway.

Running time is allotted on the basis of average performance, but there are times when a train just cannot get along as fast as it should. Chicago's rapid transit lines are particularly vulnerable to delays resulting from conflict with other trains at junctions, practically all of which involve track crossings at the same grade.

In peak hours, on CTA's principal rapid-transit line, trains are scheduled as close as 2 minutes apart, and each picks up about 800 passengers. Capacity of a crowded train is 1,000 so that a deviation in headway exceeding 25 per cent results in overloading that slows a train up, aggravating the gap. A train only a minute or two ahead of time can miss most of its load, leaving the following train a nearly impossible job. Likewise, a train only a minute or two late will have much more than its share of work to do if trains ahead have gone through on time.

Accumulation of passengers in peak hours is so rapid as to present potential for complete breakdown of service in the event of a delay of only 5 or 10 minutes. Bunching of trains may lead to power failure by concentrating too much rolling stock for the available substation capacity.

Line supervision deals with small service irregularities by controlling the spacing of trains, and with major service interruptions by centrally directed quickly executed reroutes or turnbacks. It includes modern tools for despatching trains, for recording train movements, and for direct communication to operating personnel and passengers.

SUPERVISORY EQUIPMENT

Automatic Train Despatching. Line supervision requires accurate time, furnished by a high-quality-pendulum master clock. This clock closes a control circuit momentarily every 15 seconds to operate a set of schedule controllers. Each controller determines, by means of a rolled paper tape, when trains are to leave the associated terminal or time point. Holes have been punched into this tape at the exact time that each train is to leave throughout the 24-hour day, with different tapes for weekday, Saturday, Sunday, and in some cases, Monday operation. Fig. 1 shows a schedule tape being adjusted in a controller.

Each time a punched hole in a tape comes into register with the probing finger of the schedule controller, an associated automatic train despatcher puts on the starting lights at the distant station platform through a low-voltage d-c control sent over the telephone cable. As soon as conditions permit acceptance of the starting signals, the conductor closes the doors and the motorman starts his train. As it passes over an insulated section of track, another circuit is operated over telephone lines to the automatic train despatcher putting out the starting lights.

Fig. 1. Starting of trains is initiated from a prepunched tape which carries schedule information for 26 hours

Fig. 2 is a simplified schematic diagram of the basic automatic train-despatching circuitry.

Three manual control keys provided above the recorders at the office permit introducing an extra train, annulling a train, annulling the entire schedule, and advancing or retarding the schedule tape. This gives the flexibility needed for dealing with various routine problems, as well as with major disruptions.

For Congress terminal in the Milwaukee subway, the automatic train despatcher not only provides the starting signal impulse, but also initiates the operation of an unattended automatic interlocking plant to provide a track lineup for the proper trains at starting time.

Graphic Train Records. A continuous graphic record is made of the operation of automatic train despatchers and of the passage of trains at sufficient intermediate points to provide adequate remote supervision.

At the instant a starting signal is given, a record is made on the recorder charts. Similarly, when the train actually leaves, a record is made; as it proceeds along the line, its progress is recorded by successive pens so that a series of chart pips from lower left to upper right is made by each train. Fig. 3 is a closeup of one of the recorders.

Evenly spaced service shows on the recorder charts as evenly spaced pips. Conversely, irregular spacing resulting from late or early trains is clearly visible on the charts as irregularly spaced pips.

Although the system is primarily intended for providing immediate correction to load difficulties, the charts provide

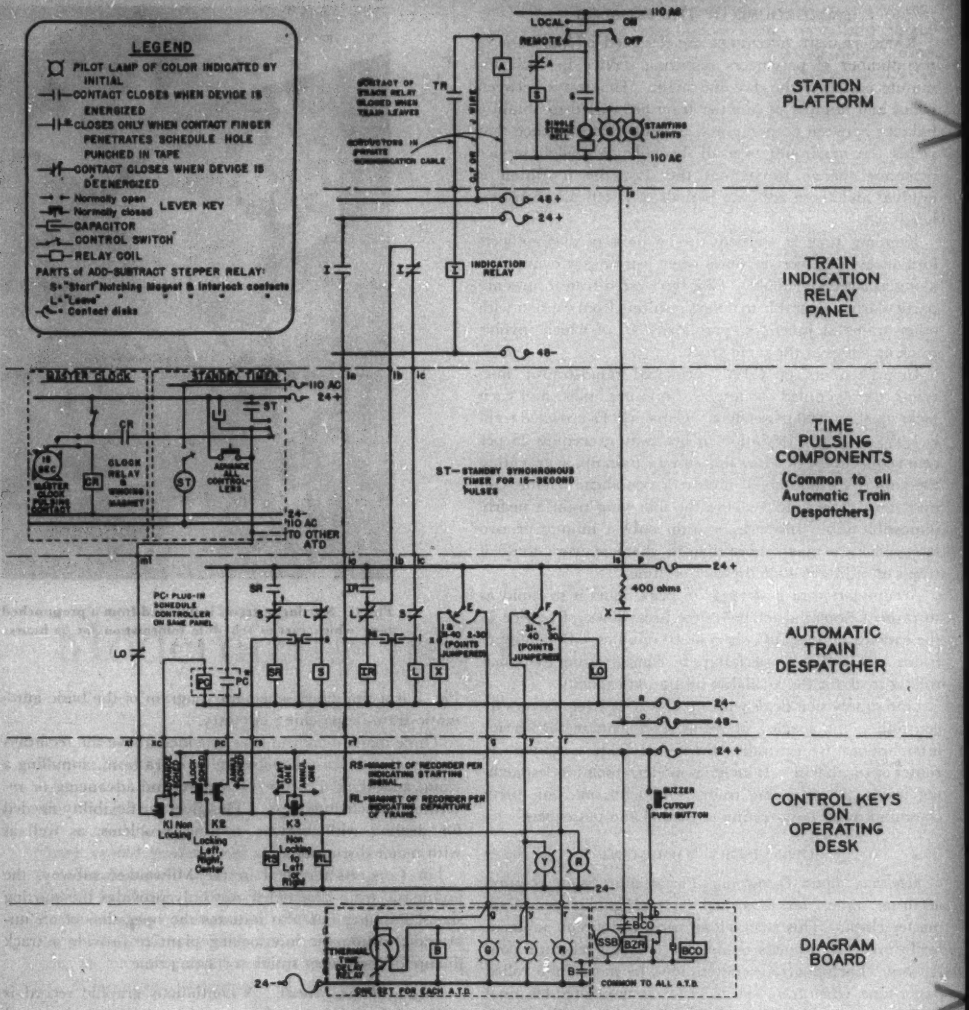


Fig. 2. Automatic train-despatching simplified schematic diagram

much valuable reference material for service improvement studies, complaint analysis, and other by-product uses.

Train Interval Timers. Since there are about 90 check points spread over the recorders, it would require extreme concentration for the operator (only one operator is on duty during lighter hours) to be sure of observing any deviation that might occur. Therefore, train interval timers are used to provide automatic supervision of key check points.

The train interval timer is an adjustable process timer connected with the train-passing indication circuits in such a way that the timer mechanism is reset and its motor restarted each time a train passes the associated check point. If successive trains fail to pass within the timer setting, the unit energizes an annunciated light upon reaching its limit.

Diagram Board and Other Supervisory Lights. On a wall map are shown all main-line tracks, crossings, crossovers, and turnouts with colored lamps set at positions corresponding to the field check points. Illumination of the colored lights describes the nature of deviation which the automatic supervision has detected:

Steady Green—Starting lights are on.
Flashing Green—Outbound track lineup is being called for

Fig. 3. Train graph recorder and automatic despatching controls

at an automatic terminal preparatory to a train departure.

Yellow—Train has left automatic despatching point without central-office authority.

Green and Yellow—Train due to leave is more than 1 minute late.

Steady Red—Schedule controller is stopped.

Flashing Red—Interval between trains is excessive.

A glance at the diagram board shows the location where delays may be developing, but it is necessary to refer to the recorder charts to determine the nature and extent of disruption, the number of trains available ahead of or behind the gap in service, and other factors that determine the proper course of action.

There is a duplicate switchboard lamp directly above the recorder pen for the associated check point. Thus, when a delay occurs, the diagram board lamp indicates the geographic location, track, and direction of the gap, and the recorder annunciator lamp spots the chart line which has recorded train operation at that check point. Fig. 4 shows the general arrangement of the diagram board as seen by the line supervisors.

COMMUNICATIONS EQUIPMENT

THE RAPID-TRANSIT LINES of CTA have been covered by a modern private-branch-exchange (P-B-X) phone system for many years. However, in cases of service deviations, the busy lines, wrong or forgotten numbers, and delays in response of conventional telephones were such a handicap that it was usually not practical to take action for minor delays, and it often was impossible to co-ordinate action for major delays. A new private communications system was, therefore, developed for line supervision.

Line-Supervision Intercom System. The special intercom system, at present, links the central office with 34 key field locations, of which 27 are part-time or full-time field-supervisor or towerman posts. These locations are distributed over three party-line channels radiating from the main office. Each party-line channel consists of two pairs of line wires, one carrying messages toward, and the other carrying messages away from, the central office.

Each station is connected to its channel through a selective call unit, which permits central to contact individually any desired station upon dialing a 2- or 3-digit code. Way stations can initiate a call by merely pressing a momentary contact key.

The 2-pair channel arrangement automatically makes the central line supervisor one party of all calls and prevents conversation between two way stations. This reduces loading of the system and directs all calls with the desired chain of command. The channel arrangement also permits loudspeaker reception without manipulation of talk–listen switches.

Paging System on Station Platforms. Some 42 train platforms at 30 stations are equipped with paging loudspeakers. These are used to reach train crews and the public with announcements. Each such platform layout includes at least one speaker opposite the berthing position of every car. Fig. 5 shows the location of speakers in a typical installation. The speakers are operated at a relatively low-volume level, which provides a clear signal along the entire platform and inside each car, without producing excessive sound spillage onto abutting property. Automatic limiter amplifiers are used throughout this project to minimize the variations in

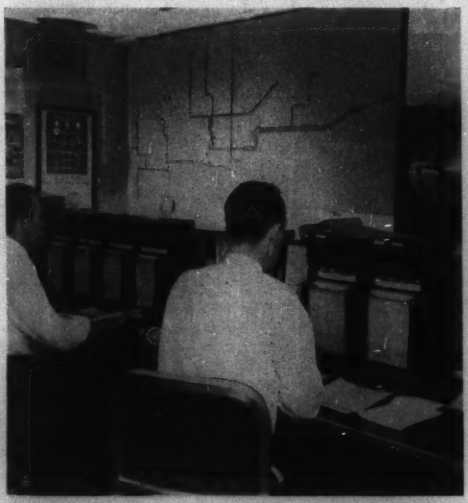


Fig. 4. Colored lights on the diagram board indicate the status of train despatching at each terminal and locations of delays

voice quality without requiring continual readjustment of controls.

At most of the stations the platform speakers can be operated by a local field supervisor working from a booth within view of the area covered. At all stations the line supervisor can make announcements directly onto these platforms when no local supervisor is on duty.

Application of Supervisory Devices. By knowing that there is a gap in service and just how much it amounts to, the line supervisor takes action to protect or advance the delayed train. Assistance is rendered, and correction of the unevenness is accomplished by:

Respacing—Holding leaders of a delayed train at points ahead of the delay, so as to pick up additional load.

Running—Ordering a seriously delayed train to pass certain stations without stopping and thus recover all or part of its delay. This is usually done when a delay approaches the scheduled headway so that a second train is immediately following. Runs are required if delays occur during peak hours when trains are loaded nearly to capacity. They are often needed to get defective trains out of the way.

Rerouting—Sending trains to stations or destinations other than scheduled, in order to provide alternate service in event of major delay or total blockade of a track or line.

In cases where car equipment trouble is suspected, the line supervisor sends the first available supervisor to meet the defective train to assist crews in clearing trouble or limping into a terminal. When he has sufficient information he also arranges with terminals to replace trains and, if necessary, to provide substitute crews so that "kickback" delays on return trips can be minimized.

Respacing is done accurately when a delay is spotted on the charts by noting the total time lost by the delayed train and dividing this among the number of leaders known to be between the delay and a control point ahead of the delay. The first of these leaders is held a small amount of time, the next a little more, and so on until the delayed train appears on an even, though retarded, interval. This technique is only effective when the spacing can be accomplished without overloading the trains held.

At Grand and Roosevelt in the State Street subway, complete automatic train-despatcher installations have been made, even though these are not terminals. In case of a delay back of these points line-wise, the respacing operation can be carried on through manipulation of the automatic train-despatcher controls by the line supervisor himself. In case of a delay along the line, which would make a train so tardy arriving at a terminal as to be unable to begin its return trip on time, the respacing technique is applied to the service starting at the remote terminal. This operation can be carried out accurately without assistance of any local personnel, and within minutes the charts provide proof of the effectiveness of the spacing job done.

Application of Communications. Running trains express past scheduled station stops, even though it is the only practical way to break up long delays, has been a dreaded therapy because of the possibility of carrying passengers by their destinations. Before the advent of platform loudspeakers it was seldom done when there were more than a few passengers on a train, but now it can be successfully accomplished under almost any conditions if circumstances warrant. The procedure begins with an announcement before the train concerned arrives, so that waiting passengers will not attempt to board a train which cannot serve them. Stations with paging speakers also have track indicators. Thus, by watching the train graph, the line supervisor sees

Fig. 5. Paging loudspeakers and despatching starting lights are located overhead along edge of platform

Fig. 6. Automatic operations of junction switch is initiated by car-borne hoop-shaped coil passing transceiver at junction

when a train has arrived. The monitoring feature of his intercom enables him to listen to background noises at the station and thereby to estimate when the train has stopped. The announcement is then repeated until it seems reasonable that it has been heard.

New car equipment added in the last 3 years is equipped with interior loud speakers over which the conductor of a train makes regular station announcements or repeats special information he hears on the platform loudspeakers.

OTHER NEW DEVELOPMENTS IN TRANSIT CONTROLS

Automatic Junction Control. Some rapid transit routes share common trackage over the inner or downtown portion of their routes and then diverge to cover wider areas in the outlying parts of the city.

From a general knowledge of railway signalling methods, it is understandable that control and protection of junction operation can be made inherent in an all-relay interlocking system to prevent conflicting inbound and outbound moves when these tracks cannot be separated in elevation. In the Lake–Paulina junction between CTA's Lake and Douglas routes, all the converging as well as diverging, conflicting and nonconflicting moves are made fully automatic and on a first-come-first-served basis. New in this installation are the identification of divergent trains and the sequential identification storage system.

Identification of all convergent trains is obtained from the track circuits approaching the junction. Identification of divergent trains is established from a radio-frequency circuit actuated only when a car-borne tuned coil passes the wayside transmitter–receiver. Fig. 6 shows the identification installation.

Above the relay case are positioned the transmitting and receiving antenna coils. An 80-kc signal is continuously beamed across the track at this point and when intercepted by a tuned doughtnut-shaped car-borne coil, resonance is produced. When amplified, this actuates momentarily a relay which encodes the track circuit information produced by that train, identifying it for the Douglas route. An approaching train not carrying the coil actuates the same track circuit, but in the absence of the encoding it is accepted for the Lake route. At present, other systems of train identification are under study.

Line Supervision of Surface Vehicles. Automatic supervisory systems for surface transit operation are a desperate need. Street-car companies pioneered in such devices 40 years ago using trolley-actuated recorders, but the high cost of line wires needed to bring supervision to a central point stymied real development. Conversion from street cars to motor buses eliminated the physical contact as a means of vehicle detection. As street traffic problems become greater, the economic facts of transit life press for fewer men and vehicles with less supervisory manpower, and the demand for improved control becomes increasingly imperative.

CTA has had research on this problem in progress for several years. A light-weight compact 200-kc transistorized transmitter has been developed which offers promise as one type of link between bus and fixed check point. Line supervision will be extended to surface operations as rapidly as techniques can be found.

CONCLUSION

WITH THE CONTROL SYSTEM CTA is now operating, central line supervisors team up with relatively few field supervisors to keep rapid transit trains rolling (Fig. 7). It has resulted in savings in operating costs through closer scheduling with less reserve capacity retained as insurance against overloading caused by service deviations. It has released manpower from train starting and checking functions formerly scattered over the line.

Fig 7. Each 6-car train represents a capital outlay of nearly one-third-million dollars; keeping it in continuous service is the responsibility of modern electric controls

The fact that a record chart is automatically made impels the supervisor to do his best in dealing with each delay as his work is recorded for reconsideration on the following day. It also helps him prove the soundness of his technique, which encourages even better future work. Likewise, the train crews, who seldom see the details of the line supervision system, respond to the knowledge that an accurate record of their work is made and that they will receive assistance promptly when any troubled conditions arise.

The psychology of announcements made calmly and clearly over loudspeakers elicits passenger co-operation rather than opposition even when the announcement conveys news that will inconvenience some people. Messages delivered the old way by trainmen or platform men invariably led to arguments and further delay.

Transformer Audible-Noise Control

W. B. CONOVER
MEMBER AIEE

R. J. RINGLEE

INFORMATION on the design of sound barriers has been obtained by model tests. A new method of noise control called "sound cancellation" is being investigated.

The nature of audible noise from power transformers may be studied with scale models. Noise attenuation possible with external walls, noise patterns about transformer tanks, and the variation of transformer noise with distance have been investigated using 1/7-scale models of 125,000-kva and 1,500-kva transformers.

With scale models, tests covering large-scale distances may be confined to an area the size of an anechoic chamber.

Fig. 1 shows the effect of a partial enclosure upon the noise pattern of a model 1,500-kva power transformer. The noise attenuation due to the enclosure may be seen in the second, third, and fourth quadrants of the polar noise plot. Some of the noise is reflected out of the open side of the enclosure, increasing the noise in the first quadrant. An acoustic liner inside the enclosure reduces reflection of noise and improves the attenuation.

Test data obtained for 2- and 3-sided model enclosures agreed with results predicted from diffraction theory, while test data obtained for 4-sided enclosures did not.

Noise patterns about model transformer tanks were found to vary considerably with azimuth angle, as may be observed in Fig. 1.

Model noise vs. distance data agreed with results on full-scale transformers.

Sound cancellation is a new technique in noise control. A "beam of silence" is produced by projecting sound waves

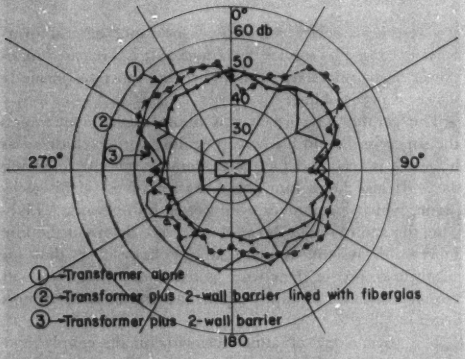


Fig. 1. Polar plot of fundamental-frequency noise for 1,500-kva model with and without 2-wall sound barrier in place. Microphone, on 81-foot radius to scale from tank center, is 7 feet above ground. Measurements taken on flat weighting network

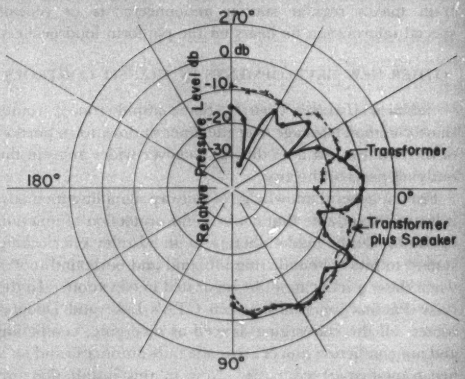


Fig. 2. Directional pattern of noise from a 15,000-kva transformer with and without cancellation from a single loudspeaker. Measurements at 100-foot radial distance from tank. Cancellation adjusted for maximum noise reduction at $\theta = 0$ degrees. Reference level is pressure without cancellation at 100 feet, 0 degrees

of equal magnitude and opposite phase along with the original transformer noise, balancing it out over a long radial path. Although still in the early stages of development, sound cancellation promises to be far less expensive than other methods of noise control.

To cancel transformer noise, a loudspeaker mounted on the transformer tank is energized with an electric signal comprising the harmonics of the noise to be reduced. By proper adjustment of the amplitude and phase of each harmonic, the beam of silence is aimed in the direction of the complaint. The beam width will depend on the particular installation, but reductions of more than 6 db throughout angles of 20 to 35 degrees have been accomplished easily in early tests. Greater angles are expected to result as techniques are improved.

Fig. 2 shows the sound pattern around a 15,000-kva power transformer before and after the injection of cancelling noise. A reduction of 6 db or more is observed in the angle from -13 to $+10$ degrees. Increases in sound level in certain other directions are shown. Tests on model transformers have shown that a 4-speaker array, which concentrates the cancelling sound, will cause a negligible increase in all other directions.

Digest of paper 55-51, "Recent Contributions to Transformer Audible-Noise Control," recommended by the AIEE Committee on Transformers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Power Apparatus and Systems*, April 1955, pp. 77–90.

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Design of a High-Power Rectifier Locomotive

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RECTIFIED SINGLE-PHASE POWER is not direct current in the usually accepted sense of the term. If the circuit has no inductances, a pulsating direct current is produced; each pulse being the upper half of a sine wave. Actually, the lower half of the sine wave has been inverted above the zero axis. If sufficient inductance can be added to the rectifier output circuit, the pulses can be smoothed out, but the amount required is so high as to be impractical. A reactor of reasonable size can be designed, however, if the ripple in the output current is held to approximately 20 per cent with maximum motor currents.

Any method of smoothing out the d-c wave has the disadvantage that it tends to cause severe distortions of the current supplied to the locomotive. This distortion sets up conditions for possible telephone influence which may or may not prove to be serious.

One effective method for improving the primary wave is to connect a capacitor-resistance filter across the rectifier input. A less effective method is to connect a tuned capacitor-reactor circuit of large capacity across the traction-motor and smoothing-reactor combination.

Two types of rectifier connections, diametric and bridge, can be used (Fig. 1). The diametric arrangement, in which the load is connected between rectifier anodes and the mid-point of the supply transformer, is economical of rectifier tubes at the expense of transformer weight and cost. With the bridge, or 2-way, arrangement the tube action and current flow during commutation are much the same, except that the smoothing reactor current does not flow through the main transformer secondary.

The smoothing reactor *SR* is used to sustain the traction motor current during rectifier commutation. Hence, for either circuit, it has to overcome the voltage drop in the two traction motors and, also, the forward drop in the rectifier tubes. The diametric circuit requires a smoothing reactor design of half the voltage and twice the current required by the bridge circuit. The two circuits compare as follows:

	Diametric		Bridge
Transformer secondary-winding current per motor, continuous	$\sqrt{2}I_m$	....	I_m
Transformer secondary power, kva	$2\sqrt{2}I_m e'$	....	$2eI_m$
Volts per rectifier tube	e	....	e
Inverse volts per tube	$2e$	....	$2e$
Tube loss (e_t = forward-tube drop)	$2I_m e_t$	....	$2I_m e_t$
Number of tubes required (same amperes per tube)	4	....	4
Transformer	Special bracing for pulsating winding currents	....	Standard design
Main smoothing reactor driving volt-amperes (e_m = motor volts)	$2I_m(e_m+e_t+e_x)$ (ex = leakage reactance volts 1/2 transformer secondary)	....	$2I_m(e_m+e_t)$
Tube arc-back current for same per cent reactance transformer (sustained value)	$I_a = \frac{1}{1.5\%X}2I_m =$ $1.33\left(\frac{1}{\%X}I_m\right)$	....	$I_a = \frac{1}{\%X}I_m$
Number of switches per voltage step	$2n$	....	n

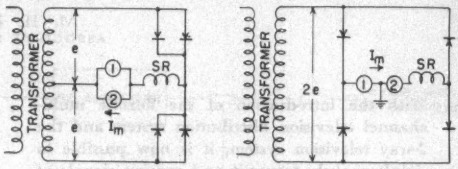

Fig. 1. Diametric (left) and bridge (right) rectifier

Ignitron tubes are limited as to the amount of arc-back current they will take for a period of one or two cycles without damage. There are two alternatives to limit arc-back currents: (1) build sufficient reactance into the main transformer; and (2) provide separate current-limiting reactances for the ignitron tubes. The former may mean a larger transformer, and high reactance in the rectifier circuit penalizes both rectifier and locomotive performance.

Telephone interference may be a major consideration in rectifier locomotive design. The primary current is far from a sine wave. During the commutating period the primary voltage wave assumes a value sufficient to force the short-circuit current through the transformer, the current-limiting reactor, and the short-circuited rectifier tubes. This produces a depression in the sine wave of primary voltage during commutation. The voltage returns to its normal sine-wave value the instant commutation is completed. With a square-current wave all odd harmonics occur with decreasing value as the order of the harmonic increases. Their magnitude may be significant until the frequency is above the range to affect telephone circuits.

Telephone interference can be reduced by: (1) connecting a resistance-capacitance circuit across the input to the rectifier tubes, (2) using a second harmonic filter circuit, and (3) phase shifting. Test and experience have shown that item 2 is not effective; field test of item 3 have achieved a certain amount of success; while item 1 gives a greater improvement in telephone interference. It is a simpler method and can be varied over wide limits.

REFERENCES

1. Rectifier-Type Motive Power for Railroad Electrification, **L. J. Hibbard, C. C. Whittaker, E. W. Ames.** AIEE *Transactions*, vol. 69, pt. 1, 1950, pp. 519–24.

2. The Pennsylvania Railroad Ignitron-Rectifier Locomotive, **C. C. Whittaker, W. M. Hutchinson.** *Ibid.*, vol. 71, Pt. 2, 1952, pp. 37–47.

3. Rectifier Motive Power—Inductive Co-ordination Considerations, **E. B. King, K. H. Gordon, L. J. Hibbard.** *Ibid.*, vol. 73, pt. 2, 1954, pp. 107–17.

Digest of paper **55-208**, "Considerations in the Development of a High-Power Rectifier Locomotive," recommended by the AIEE Committee on Land Transportation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Applications and Industry*, July 1955, pp. 169–76.

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Developments in Closed-Circuit Television

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With the introduction of the flexible multichannel television distribution system and the 2-way television system, it is now possible to simultaneously transmit and receive signals at a number of pickup-reception points in the system. The operation of these two systems are explained for those installed at Fort Monmouth and Case Institute of Technology.

THE DEVELOPMENT of closed-circuit television has been marked by many fascinating applications, but until recently, economic factors ruled out its mass usage in many fields. In industry, education, business, and the military, television has been a fascinating medium to explore, test, and evaluate, but only infrequently could its proponents justify its introduction on a permanent large-scale basis. Recently, however, advances in two fields have turned the tide.

The first development was the perfection of the vidicon pickup tube, and the subsequent introduction of vidicon cameras selling for a fraction of the cost of studio-type image orthicon units. Prices have been reduced to the point that today it is possible to make an installation between $1,000 to $5,000 with features and performance to meet almost any task. With this has come a host of familiar single-camera applications. Industry has quickly accepted television as a means for watching loading platforms, smoke stacks, rolling mills, and scores of other situations where it is essential for a single operator to know the action taking place at a single remote point. Educators and business men have found similar needs. Important though these applications are, the limits placed on the number of cameras and the number of pickup-reception points, which can be economically and effectively covered by an elementary installation, for a time put a virtual ceiling on the extent of television applications.

The development of the flexible television distribution system has eliminated this barrier. It is now possible not only to simultaneously transmit a number of signals inexpensively, but at the same time to either permanently install cameras or insert portable cameras at many points in a system, thus providing the ultimate in flexibility, while maintaining complete control over each channel.

Before investigating these new developments, it is well to consider some of the costs heretofore associated with the larger closed-circuit installations. Assuming a need for a high-quality interlaced picture, the camera with viewfinder, lens, and tripod cost between $3,000 and $5,000. The television receivers added between $125 and $250 per viewing location, while installation costs in a 10-set single-channel r-f or video distribution system, within a medium-sized building, varied from $200 to $1,000. With the addition of maintenance and parts for the first year of $500, the total cost quickly reached between $5,000 and $9,000. Furthermore, if the system was used to watch animated scenes,

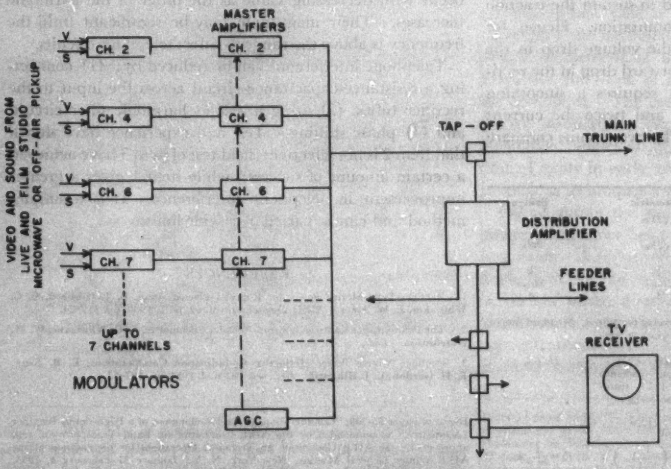

Fig. 1. Basic television distribution system

Full text of paper 55-687, "Developments in Closed-Circuit Television," recommended by the AIEE Committee on Television and Aural Broadcasting Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 3-7, 1955. Scheduled for publication in AIEE *Communication and Electronics*, 1955.

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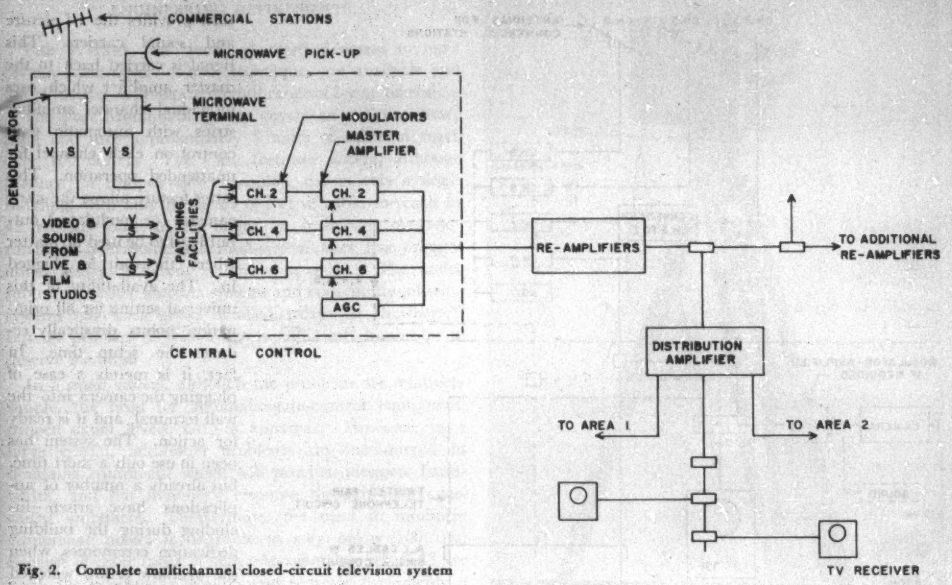


Fig. 2. Complete multichannel closed-circuit television system

such as are found in education, the cost of one or more cameramen or operators was added, plus the studio or other central-control requirements. Finally, moves or changes presented phenomenal problems. The setup and rebalancing time alone made it feasible to move the camera or the receivers only for events of the first magnitude.

MULTICHANNEL DISTRIBUTION SYSTEMS

It was against this background that the flexible multichannel television distribution system was introduced. As shown in Fig. 1, a basic system consists of modulators or "miniature transmitters," master amplifier, coaxial cable, distribution equipment, and receiver connection accessories. The television installation at Fort Monmouth, N. J., utilizes a large system of this type, and serves to illustrate both a military and an educational application. As shown in Fig. 2, both live and film programs are originated in the studios and distributed throughout the training areas of the post by a 3-channel system operating on channels 2, 4, and 6. Over 100 classrooms, various theatres, and the field house are served, so that students receive both training in their studies and general orientation- and information-type programs. In addition, programs picked up from commercial stations are presented as well as "remotes" microwaved from other parts of the post. Evidence points to the fact that thousands of lost training hours have been eliminated, since it is no longer necessary to move troops from one area to another to receive instruction. Furthermore, films can be shown without darkening the room—so students stay alert and can take notes—and the teaching continuity is not broken as is the case when the instructor takes time to set up and operate the movie projector, or move the class from one room to another for a viewing. Films last longer and many duplicate films and projectors can be eliminated. Thus, the television distribution system with its multichannel capabilities and classroom outlets has become an invaluable training medium.

In industry or business, this same type of system can be used in many ways, including providing scheduling and status information from a central point to many subordinate points. In other cases, the closed-circuit function can be combined with master television antenna system needs to provide both "air channels" and closed-circuit channels over the same cable. Security needs can be met too. Techniques which will be discussed later make it possible to restrict certain channels to be viewed at specific receivers, even though all channels are carried over the same cable. Even with these refinements, a closed-circuit system based on one or, at best a few, origination points has severe limitations.

2-WAY TELEVISION

In many dynamic applications, the limitations imposed by single-point origination are a severe handicap. The 2-way television system has eliminated this handicap and opened a new dimension in television flexibility. The workings of 2-way television can be seen by a description of the system in the new electrical engineering building of the Case Institute of Technology in Cleveland, Ohio.

During the planning of the building, an analysis of the teaching requirements showed the need for a way to give large groups of students a close view of experiments and other demonstrations being conducted in other rooms and

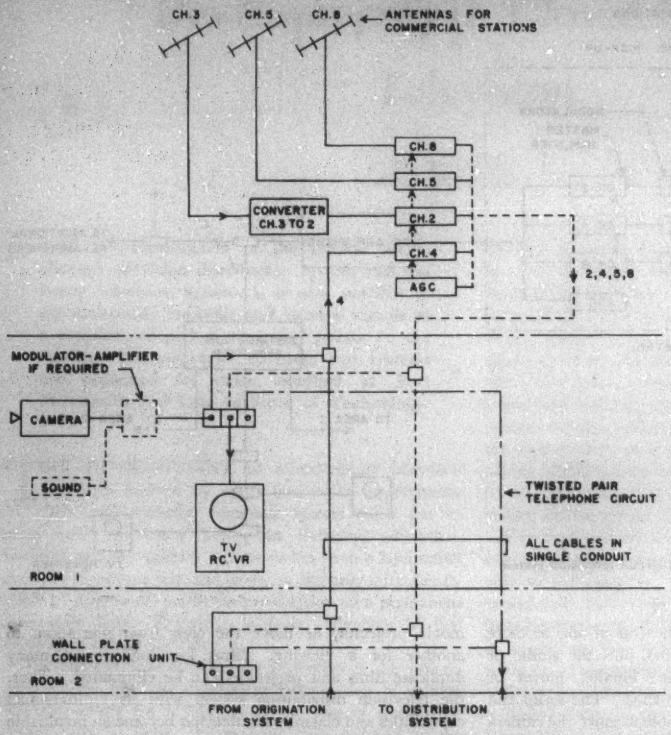


Fig. 3. Basic 2-way television-system unattended central facilities

laboratories throughout the building. A portable television camera appeared to be an ideal answer if a way could be found to move the camera from point to point without extensive setup procedures. It was felt that while initial provision should be made for the origination of only one program, the system should be expandable so that additional channels could be made available at television receiver outlets throughout the building. In addition, the lecturer using the "remote" demonstration should have voice contact with the assistant operating the demonstration and with the cameraman. Finally, a regular master antenna system should be provided so that the three Cleveland commercial stations, channels 3, 5, and 8 would be available. These needs were met by the system shown in Fig. 3. All major classrooms, laboratories, and lecture halls have a connection point for a television receiver, a television camera, and a pair of sound-power phones. As shown by Fig. 4, a total of 34 rooms are thus equipped for 2-way television, and 11 others provided with a receiver connection point.

In operation, the remote r-f television signal is fed into the system on channel 4 directly from the camera or, if sound is desired too, the camera video output and the audio signal can be used to drive a modulator which in turn provides the r-f picture and sound carriers. This signal is carried back to the master amplifier which uses individual channel amplifier strips with automatic gain control on each channel for unattended operation. This latter feature allows the same camera (or modulator) output level to be used no matter where the unit is plugged in. The availability of this universal setting for all origination points drastically reduces the setup time. In fact, it is merely a case of plugging the camera into the wall terminal, and it is ready for action. The system has been in use only a short time, but already a number of applications have arisen—including during the building dedication ceremonies, when the overflow crowd watched the ceremonies by television in adjoining rooms.

Educationally, this type of system has possibilities which must be analyzed by the educators—a field foreign to this article. However, several points are clear. Costwise, it eliminates the studio requirements entirely and instead of requiring highly trained personnel, it can be operated by a laboratory assistant or student. Tests have shown that, productionwise, the program need not measure up to commercial standards.[1] Functionally, it can be used either as a teaching aid or a teaching medium. As an "aid," it can bring a large piece of equipment into the classroom, or magnify one too small to be seen simultaneously by all students. As a teaching medium, it enables the professor to remain in his natural habitat, and would thus seem to meet most educational television needs. The latter is particularly true if in evaluating the programs one keeps in mind that the major goal of educational closed-circuit television is the creation of programs which teach, rather than ones which sell or entertain. Furthermore, the flexibility feature enables the educator to take full advantage of all of the possibilities of television, instead of merely televising the traditional educational methods.

In industry and business, 2-way television has many as yet untapped uses. Plants can be wired so that cameras can be plugged in at any time to observe troublesome operations, to collect data, or even to "tour" the facilities. Wherever low cost, flexibility, and ease of operation is important, the system can be applied.

ENGINEERING REFINEMENTS

THE SYSTEMS just described were designed to meet certain basic needs. Other techniques are available and are of interest to illustrate the full range of 2-way television.

The Fort Monmouth system covers an entire military post, and uses approximately 5 miles of cable to reach over 100 outlets. The Case Institute system, although planned for campus-wide expansion, covers only a single building, with only hundreds of feet of cable to reach its 45 receiver outlets. As might be imagined, the wide range of television-distribution-system sizes has brought about several different system approaches. The entire subject of master antenna systems and community antenna systems has been given detailed treatment elsewhere,[2,3] but the problem of system size is sufficiently important to deserve mention.

In a small system, although the problems are relatively simple, the need for automatic-gain-control equipment, proper signal levels, etc., is apparent. However, in a large system, additional problems are encountered in designing equipment which will provide adequate bandwidth, and flat frequency response through many cascaded amplifiers. Furthermore, the need to minimize equipment makes it desirable to stay below 100 mc; because of cable losses, if high television channels 7–13 are used, the equipment requirements increase by roughly a factor of 4 for amplifiers of the same gain and output. These additional factors have created the need for two types of systems: signal distribution systems, and signal transport systems.

The Case Institute system utilizes only signal distribution, which is accomplished by individual channel amplifier strips with automatic gain control, located at a central point. As discussed, both low channels 2, 4, and 5, and a high channel 8 are used. Compensation for the difference in attenuation between channel 2 and channel 8 is accomplished by setting the output level of the channel 8 strip higher than that of the channel 2 strip, and by using capacitive tapoff units, which have a lower attenuation on the high channel than on the low.

A 5-channel transport system is shown in Fig. 5. This system uses channels 2, 4, and 6, to which have been added channels designated as 03 and 05, occupying the bands 40.5–46.5 mc and 24.5–30.5 mc, respectively. The relation between the two subchannels is determined by the desire to convert these to channels 3 and 5 for eventual distribution to the television receivers. The operation of this system imposes no unusual requirements. Only one departure from normal tech-

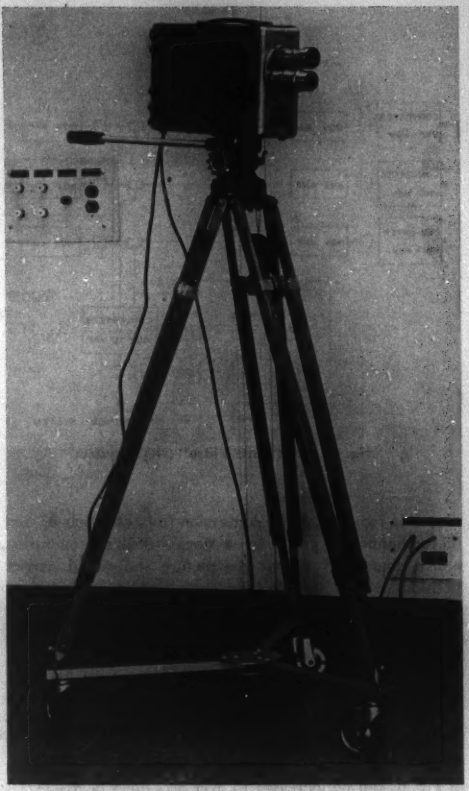
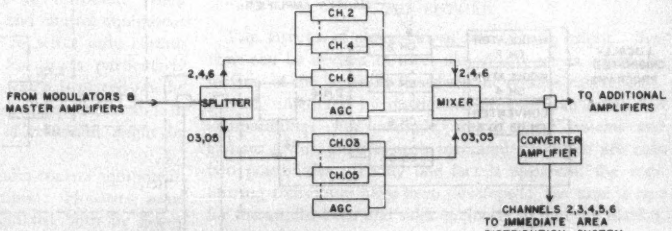


Fig. 4. Vidicon camera connected to system. Wall connection point for television camera, receiver, and a pair of sound-power telephones are shown on the right



CHANNEL	PICTURE CARRIER MCS	SOUND CARRIER MCS
03	45.25	40.75
05	29.25	24.75
2	55.25	59.75
4	67.25	71.75
6	83.25	87.75

Fig. 5. Five-channel transport system, occupying the bands 40.5–46.5 mc and 24.5–30.5 mc

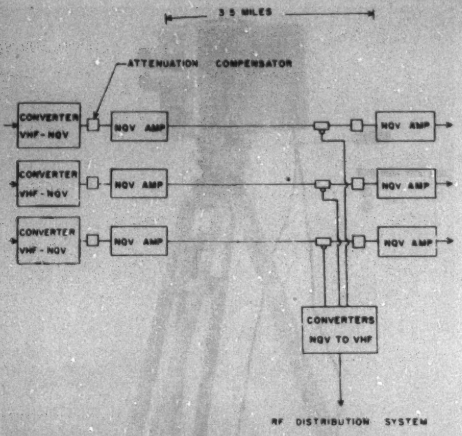


Fig. 6. "Not Quite Video" (NQV) system

niques is required. The conversion from channels 03 and 05 to channels 3 and 5 by a single oscillator operating above channel 5 inverts the picture and sound carrier positions. It is therefore necessary, when originating a program at the 03 or 05 frequencies, to originate it with the picture and sound portions inverted, so that they come out "right side up" in the distribution system.

When the signals are to be carried over very long distances, another technique has been found effective. This system takes advantage of the further reduction in cable losses found between 1 and 7 mc. By using these "Not Quite Video" (NQV) frequencies, the amplifier spacings, as shown in Fig. 6, can be increased to over $3^1/_2$ miles of *RG-11/U*-type cables. Since all channels are between 1 and 7 mc, a separate cable must be used for each. However, installation cost is not appreciably increased by adding additional parallel cables, so that with a reduction in the amount of electronic equipment needed, the system has many attractive low-cost features.

In all types of signal transport systems, the type of coaxial cable is of extreme importance. Recently developed cables, having a more uniform frequency response and lower temperature coefficient of attenuation, have materially assisted in the successful operation of long signal transport systems. Furthermore, these new cables (*JEL*-type) utilize a high-molecular-weight noncontaminating polyethylene jacket, in place of the traditional vinyl jacket used on most *JAN*-type cables. This new jacket materially increases cable life and, therefore, system life.

The transport-system technique has further reduced the cost of closed-circuit systems. For example, if distribution of only two channels is required, but over a large area, channels 03 and 05 can be used. This minimizes equipment and maintenance, and it is merely necessary to provide inexpensive converters at the television receivers to convert channels 03 and 05 to regular vhf channels.

Channels 03 and 05 can be used in another way. The Case Institute System is a double cable system: one for origination, one for distribution. If only a few channels are required it is possible to send the remote programs from the camera to the central amplifier on channels 03 and/or 05, while distributing these or other programs on channels 2, 4, and 6—all over the same cable. As shown in Fig. 7, this technique has the advantage of eliminating the second cable, and is particularly valuable in providing 2-way-television coverage over a large area with a minimum of cable.

The subchannels have even another use—program zoning. For example, it may be desirable to distribute three programs to all television receivers in an area, and

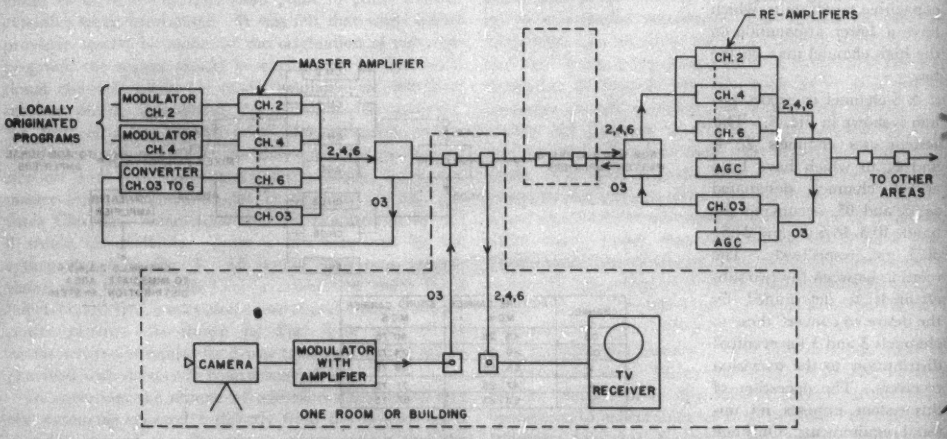


Fig. 7. Single-cable 2-way television system

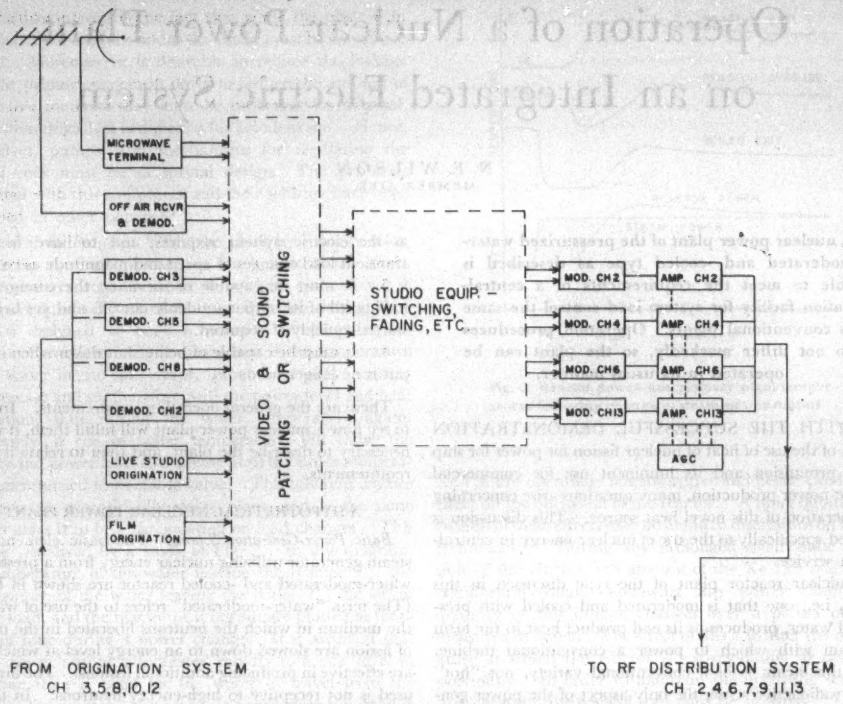


Fig. 8. Central-control facilities for attended operation

to have two additional programs available to only certain ones. This can be accomplished by distributing channels 03, 05, 2, 4, and 6. All receivers then can use channels 2, 4, and 6, but only those equipped with a special converter can receive the restricted 03 and 05 programs.

When desired, another form of control can be instituted—program selection. It is possible to introduce timed automatically sequenced switching and control equipment at the "head-end" of the system to select only certain programs for distribution. This feature is particularly adapted to hospitals where a close watch is placed on the program content reaching "disturbed" patients and in schools where indiscriminate use of television might be objectionable.

No mention has been made of studio control equipment, because in most cases none is required. However, some applications require programs originated both by 2-way television and by studio techniques—either film or live. This is particularly true where central movie telecasting facilities are provided. In this case, the automatic design whereby a program originated at a remote point is automatically distributed to the entire system is eliminated. In its place, demodulator units are provided as shown in Fig. 8, which reduce the incoming r-f signals to the lowest common denominator of video and sound. These signals can then be switched or combined with other signals through the use of regular studio equipment, and then fed into modulators for subsequent distribution. In this way a program can be made up of sequences involving remote live pickup, studio pickup, slides, and film.

THE FUTURE

THE FUTURE of closed-circuit television is bright. Systems can be devised to meet almost any needs, especially in view of the fact that closed-circuit systems can be engineered, unfettered by restrictions on spectrum space and compatibility. For example, special color systems and systems giving pictures with increased resolution are only two possibilities. Today one fact is apparent, the engineering techniques have been developed; the time is ripe for the applications and sales engineers to find the market.

REFERENCES

1. Television in Army Training: Evaluation of Television in Army Basic Training, **Joseph H. Kanner, Richard P. Runyon, Otello Desiderato.** HumRRO Technical Report 14, Human Resources Research Office, The George Washington University, Washington, D. C., November 1954.

2. Line Amplifiers for Community Television Systems, **K. A. Simons, Don Kirk, H. J. Arbeiter.** AIEE *Transactions*, vol. 73, pt. 1, 1954, pp. 214-20.

3. TV Master Antenna Systems (book), **Ira Kamen, Richard Dorph.** John F. Rider Publications, New York, N. Y., 1951.

Operation of a Nuclear Power Plant on an Integrated Electric System

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A nuclear power plant of the pressurized water-moderated and -cooled type as described is able to meet the requirements of a central-station facility for system load control the same as conventional plants. Operation procedures do not differ markedly, so the plant can be operated in its usual manner.

WITH THE SUCCESSFUL DEMONSTRATION of the use of heat of nuclear fission for power for ship propulsion and its imminent use for commercial electric-power production, many questions arise concerning the operation of this novel heat source. This discussion is directed specifically to the use of nuclear energy in central-station service.

A nuclear reactor plant of the type discussed in this article, i.e., one that is moderated and cooled with pressurized water, produces as its end product heat in the form of steam with which to power a conventional turbine. Since this steam is of a conventional variety, not "hot" in the radioactive sense, the only aspect of the power generating plant to be concerned with is that portion dealing strictly with steam production, i.e., the part of the plant corresponding to the steam generator through to the main steam header of a conventional plant.

What are some of the operational characteristics of a steam generator which the operators of central-station facilities have come to regard as either necessary or desirable? In broad terms the requirements are:

1. It must be possible to start the steam generator when wanted without excessive waiting periods.
2. It must be possible to load it to full capacity as fast as the electric system requires, and to have it absorb transient load changes of speed and magnitude as required.
3. It must be capable of surviving the emergency of having all of its output suddenly cut off, and yet being restarted quickly if required.
4. It must be capable of being shut down when its output is no longer needed.

These are the general operating requirements. In order to see how a nuclear power plant will fulfill them, it will be necessary to describe the plant, and then to relate it to the requirements.

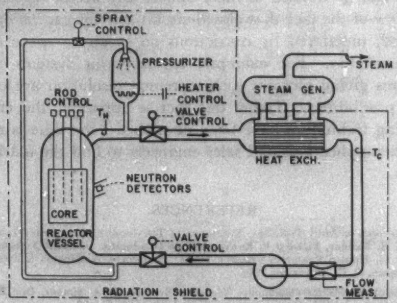

Fig. 1. Nuclear power plant

A HYPOTHETICAL NUCLEAR POWER PLANT

Basic Power-Generation Scheme. The basic elements of a steam generator utilizing nuclear energy from a pressurized water-moderated and -cooled reactor are shown in Fig. 1. (The term "water-moderated" refers to the use of water as the medium in which the neutrons liberated in the process of fission are slowed down to an energy level at which they are effective in producing additional fissions. The uranium used is not receptive to high-energy neutrons. In the reactors described, ordinary water is used for this function, as well as to carry away the heat generated.)

The core, in which the heat is liberated, is contained in a pressure vessel through which water is channeled. The water, having absorbed the heat of fission, passes out to the heat exchanger where the heat is transferred to the secondary water from which the steam is made. The cooler water leaves the heat exchanger and returns to the pressure vessel and core. Circulation is maintained by the circulating pump. In order to generate steam at temperatures greater than 212 F, the entire primary system is under high pressure so that boiling does not occur in the core at the elevated temperatures at which the primary plant operates. This pressure is regulated in the pressurizer by a spray and heater control system to a reasonably constant value.

Of interest to the user of the steam is the fact that, although the water in the primary system becomes radioactive while it passes through the core where it is subjected to intense neutron irradiation, its radioactivity is not in the form of neutron production so that it does not make the secondary or steam side of the plant radioactive. Hence, all parts of the plant containing the primary system must be shielded, but the parts containing the steam system alone require no shielding.

Full text of paper 55-749, "Operation of a Nuclear Power Plant on an Integrated Electric System," recommended by the AIEE Committees on Nucleonics and Power Generation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 3–7, 1955. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1955.

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Of further interest is the fact that while the plant is in operation all operations under the shield must be by remote control. Moreover, it is desirable to reduce the leakage from the primary system in order to reduce the amount of radioactive material that must be processed for disposal. The system described is designed for zero leakage. Hence, the valves, pumps, and mechanisms for regulating the control rods must be of special design. The problems associated with this equipment and their solution have been described in other papers.[1,2]

Control of the Reactor. When the plant is at steady state, the reactor core will produce as much heat as the steam system removes from the water at the heat exchanger. A characteristic of reactors of the type described is that they may be designed to have a negative temperature coefficient of reactivity. This means that if the temperature of the water in the core drops, the activity of the reactor will increase and so, therefore, will the power level and heat generation, thus raising the water temperature again. Conversely, a rise in water temperature will cause the activity and power level to decrease until the water temperature has returned to its stable value. This inherent feature results in an exceptionally stable plant, and at the same time enables it to be self-regulating on load changes. This can be visualized by a study of Fig. 2. In this diagram, the temperature of the water leaving the reactor T_R, the temperature of the water leaving the boiler T_C, the steam power load, and the reactor heat output are plotted as functions of time during a power change. It is assumed that steam power output is increased rapidly to a new level in less time than it takes for the water to travel from the boiler to the reactor. The reactor power does not change until the colder water reaches the core. The colder water causes the reactor power level to increase, increasing the temperature of the water leaving the reactor. The power level of the reactor will increase as long as the average temperature of the water is below normal. As soon as the reactor has restored the energy initially taken from the water it will settle to the new heat output needed to maintain the power flow equilibrium. The action described occurs without external regulation. Its effect is to restore reactor (and boiler) average temperature to its former value following the transient caused by a load change.

During the production of energy by nuclear fission, various end products of the fission process accumulate within the fuel. These are the elements into which uranium splits. Some of them are initially formed as an isotope of one element and decay with time to another, and with further time to still another. One of these of interest is a xenon, Xe 135, which is important because it is highly effective in absorbing neutrons, thus preventing them from being useful in fission. The absorptive effect is similar to that of the control rods. This isotope of xenon is formed as a decay product of iodine which is substantially a fission product.

The Xe 135 is eliminated by two means: It will decay radioactively to an isotope of cesium, Cs 135, but its decay takes longer than its formation. In the presence of a neutron flux, i.e., when the reactor is at power, it is changed by neutron absorption into Xe 136. Both the Cs 135 and the Xe 136 are essentially nonabsorptive and hence produce no effect on the operation of the reactor. A more detailed discussion of these effects may be found in discussions on reactor technology.[3,4] During any prolonged steady-state operation of the reactor, the amount of the Xe 135 reaches an equilibrium value. Following any power change the quantity of this isotope changes over a period of time, measured in hours. The effect of this is to alter the temperature at which the reactor is self-regulating as described previously. In order to maintain the operating temperature constant, the control rods must be adjusted. This adjustment may be manual or automatic, the automatic control being based on temperature.

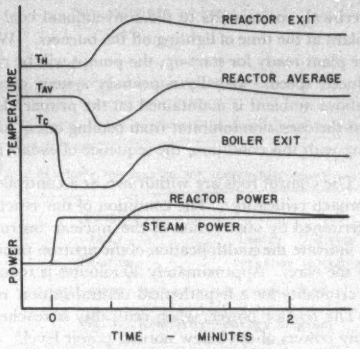

Fig. 2. Reactor power- and primary-plant temperatures following change in steam-power output

The result of the control features described in the foregoing is shown in Fig. 3. On this diagram, the various reactor temperatures are plotted as a function of plant power output for steady-state conditions and constant flow of the primary coolant. The average temperature of the reactor is maintained constant by regulation of the control rods as the amount of xenon changes. The reactor outlet temperature increases and the reactor inlet temperature decreases as the plant output increases. The effect of maintaining the average temperature of the primary coolant constant is to produce a steam temperature and, hence, steam pressure which varies with load. In a unit system, this variation of pressure, although not conventional, is not detrimental.

If the plant is to be scheduled for light load, the coolant flow may be reduced by a reduction in pump speed. The result of this operation is illustrated by Fig. 4. The pumps are operated at one-half speed for loads to 50 per cent of plant capability, and at full speed for loads from 50 to 100 per cent of plant capability. The advantage of this is the considerable savings in pumping power for light-load operation. The power required for the pumps at one-half speed is only one-eighth the power required for full speed.

OPERATION OF A NUCLEAR POWER PLANT

Plant Start-up. The reactor plant at ambient temperature with the plant checked out preparatory to making the re-

actor critical, corresponds to the conventional coal or oil-fired plant at the time of lighting off the burners. With the reactor plant ready for start-up, the pumps will be running at reduced speed. Usually a primary system pressure a little above ambient is maintained on the primary loops to prevent the corrosion inhibitor from coming out of solution. Starting with this condition, the sequence of events is:

1. The control rods are withdrawn at a controlled rate to approach criticality. The condition of the reactor can be determined by observation of the nuclear instruments, which indicate the multiplication of the neutron population within the core. Approximately 20 minutes is required to attain criticality for a hypothetical central-station reactor.
2. The reactor power, when criticality is reached, will be many powers of ten below normal power level. By adjustment of rods the reactor will be placed on a "positive period," which means that power will multiply at a regular rate until normal power range is reached. It will take 10 to 15 minutes to raise power to the vicinity of 10-per-cent power when plant warm up can begin.
3. With the reactor at a power level sufficient to raise temperature at 150 to 200 F per hour, approximately 3 hours will be required to warm the plant to the operating temperatures of present-day technology. The primary loops are pressurized by operation of the heaters in the pressurizer to keep pace with the increasing temperature.
4. The turbine may be rolled as soon as adequate steam pressure is available, if it is desired to do so. Load may be placed on the turbine as soon as it is at operating speed.
5. When the primary plant reaches design temperature it may be placed in automatic control which will operate to hold the average-temperature constant.

The process of starting up and bringing the plant to full-power operation thus requires $3\frac{1}{2}$ to 4 hours, if it is initially at ambient temperature. If the plant is at or near design temperature, as it would be following an overnight shutdown, the time would be about an hour, consisting of the time required to attain criticality and power-range operation, plus the time required to place the turbine in operation.

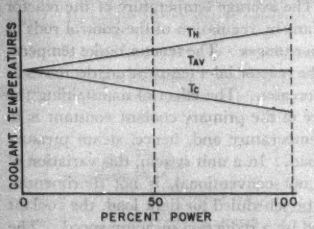

Fig. 3. Temperature vs power; pumps at full speed

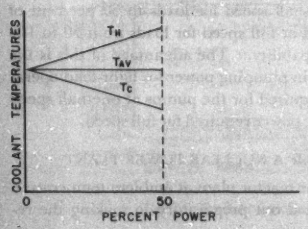

Fig. 4. Temperature vs power; pumps at half speed

Plant Operation in the Power Range. There is essentially no inherent restriction on the rate at which the reactor plant can pick up load. The rate at which the turbine can assume load is the determining factor. For decreasing loads, the rate at which load is removed will affect the design of the primary plant in that the pressurizer must be capable of keeping the primary pressure within design limits. The size of step load reductions that can be accommodated by a nuclear power plant of the type considered will depend on the size of the pressurizer and the volume of the primary system. Nevertheless, without oversizing the pressurizer above the size required for maintenance of normal primary water inventory, the reactor plant is able to accommodate reductions in load of 20 to 30 per cent of the plant rating as fast as the turbine throttle can close for load changes, normally 2 to 3 per cent per second. It is able to take a complete load cutback from 100 per cent minimum or zero load at a rate of 5 to 10 per cent per minute. These rates of load change more than meet the needs of central station practice.

Emergency Load Reduction and Recovery. Two types of emergency load rejection are of interest: generator-breaker-trip, and steam throttle-trip. In either case, the steam pressure relief valve will probably open. It is not necessary to shut down the reactor if the transient primary-loop temperature rise can be prevented from exceeding a design limit by controlled steam exhaust until the reactor power has cut back. In this case, the unit may be restored to service as fast as the steam and electrical plant can be recovered.

If the reactor emergency shutdown is tripped during these emergencies, the rods will have to be withdrawn again, and criticality regained. The process of restoring the reactor to power level will take 15 to 30 minutes, depending on the mechanism for safety shutdown, and the length of time before rod withdrawal is begun.

Plant Shutdown and Start-up After Normal Shutdown. The process of shutting down a reactor is no more involved than shutting down a conventional plant. After the steam load has been reduced to zero or minimum, the rods are inserted to make the reactor subcritical. Two factors are present, however, which make the nuclear power plant differ from the conventional. These are decay heat, and the xenon effect. A discussion of these factors and their effect on plant operation follows.

Insertion of the rods causes the reactor to become subcritical and reduces the production of fission heat to a fraction of a per cent essentially at once. However, the radioactive decay of fission products within the core will produce heat equal to a few per cent of full power immediately following shutdown from full-power operation. This decay heat power will decrease exponentially with time. There will be a period of several hours during which the decay heat is greater than can be dissipated by thermal radiation from the primary plant. Hence, some circulation of primary coolant must continue through the core, and means

must be provided for the removal of the heat from the primary system. This may be in the form of a small auxiliary condenser fed from the steam mains.

The formation of the isotope Xe 135 was referred to previously. It was stated that during any steady power operation, the formation of Xe 135 and its destruction by neutron flux reach an equilibrium state. When power is decreased to zero the destruction of Xe 135 by neutron absorption ceases. Hence, the amount of xenon present increases quite appreciably until its loss by radioactive decay becomes greater than its formation by radioactive decay of its parent isotope I 135. The operating effect of xenon, following a shutdown, is to require greater withdrawal of control rods to attain criticality on restarting. Coincidentally, the time at which this effect is at a maximum following shutdown, is approximately the same as a normal overnight plant shutdown. Since the amount of xenon that will be present is such a complicated function of the operating history of the reactor, the position of the rods for criticality can never be known in advance.

Effect of Core Age on Plant Operation. When a particular core is new, it will have the ability to maintain criticality with any amount of xenon that may accumulate as the result of operating history. Operationally, this means that the plant is fully flexible with respect to the size of power changes to which it is subjected. It may be shutdown after extended power operation and be started up at any time thereafter. As the amount of energy taken from the core increases, the excess reactivity available decreases through the depletion of fissionable uranium, until a point is reached at which the peak xenon can no longer be overriden at design temperature. The equivalent full-power hours of operation obtainable before this condition occurs is subject to design.

The condition described is illustrated by the diagram of Fig. 5. On this diagram the components of reactivity are plotted as ordinates, with total energy removal, or equivalent full-power hours, as abscissa. Thus, when the core is new, it can be critical at *A* if it is cold. As the plant warms up, the rods must be withdrawn to *B* because of the negative temperature coefficient of reactivity. If the plant is brought to full power and operated there for several hours, equilibrium xenon for full power will be built up and the rods must be withdrawn to *C* to maintain criticality. If the power is reduced to zero or very low value, transient xenon will build up, and in about 8 to 10 hours the rods would need to be out to *D* to maintain criticality or to restart the plant if it had been shut down.

From a study of Fig. 5 it can be seen that up to time *a*, in full power hours, there is always enough reactivity to enable the plant to be made critical and reach full power for any operating condition. Operation beyond point *a* is possible and, depending on core design, there may be considerably more energy usable than was obtained in reaching point *a*. The plant may be operated at full power at full design temperature up to point *c*. Between *a* and *b* slightly limited operation may be obtained in that the plant can be subject to normal load swings, but if it should be shut down for 8 to 10 hours, it would be necessary to start up at reduced temperature. If the temperature at which criticality can be

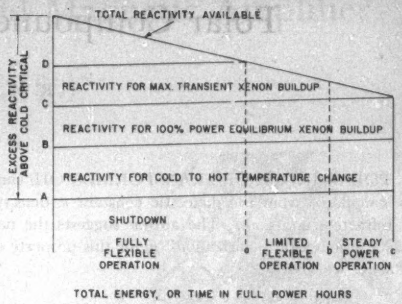

Fig. 5. Reactivity—energy diagram

obtained is high enough so that an appreciable amount of power can be developed, perhaps 50 per cent, the transient xenon will burn out sufficiently in 2 or 3 hours to permit operation at full temperature and power. Thus point *b* is partially determined by the steam plant and turbine.

Beyond point *b*, the plant can be operated at or near full load as a base-load plant until point *c* is reached. Beyond *c*, operation would require that plant temperature be reduced an increasing amount as operation is continued.

It is interesting to note that the life cycle of a particular core is the reverse of the whole life cycle of a conventional steam plant. Most steam plants are used as base-load plants when new, because their efficiency is higher than existing plants. As newer plants come on the line, the existing ones are used increasingly as swing or regulating plants. A new core in a nuclear energy plant has the ability to operate with full flexibility when it is new. As its age increases, some of the operational flexibility is lost, but much additional energy may be obtained without incurring additional fuel handling charges for reloading by continuing its operation as an increasingly base-loaded plant.

Since the points *a*, *b*, and *c* are a function of design, operation of the plant during the life of a core can be scheduled in advance. Part of the economics of nuclear power will involve the scheduling of core energy to fit in with the operation of the system in the best manner.

CONCLUSION

THE INTRODUCTION of a nuclear heat source for electrical power production does not introduce operational procedures that are markedly different from conventional practice. The operator of such a heat source will find new names on his instruments and controls, but when he has learned their meaning, he will find that he is using the plant in the old and familiar way.

REFERENCES

1. Position Control in Sealed Systems, **W. H. Esselman, W. H. Hamilton.** *Proceedings*, 1953 Conference on Nuclear Engineering, California Book Company, Ltd., Berkeley, Calif.

2. A Very Low Speed Drive with Flooded Rotor Motor, **W. E. McCown.** *Electrical Manufacturing*, New York, N. Y., vol. 54, August 1954.

3. Element of Nuclear Reactor Theory (book), **S. Glasstone, M. C. Edlund.** D. Van Nostrand Company, Inc., New York, N. Y., 1952.

4. Introduction to Nuclear Engineering (book), **R. L. Murray.** Prentice-Hall, Inc., New York, N. Y., 1954.

Polar Compounds in Transformer Oil

R. W. JOHNSON

A POLAR INDEX OF TRANSFORMER OIL can be calculated from the dielectric constant ϵ, density d, and refractive index n_D. The author suggests the name "specific orientation polarization" p_o for this property of a substance, whereby

$$p_o = p - p_d = \frac{\epsilon - 1}{\epsilon + 2}\frac{1}{d} - \frac{n_D^2 - 1}{n_D^2 + 2}\frac{1}{d} \quad (1)$$

The name "specific concentration" is suggested for the ratio of the concentration of polar compounds at a given interfacial-tension to that concentration which would give an interfacial-tension of 30 dynes/cm. Since this function of the interfacial-tension varies linearly with concentration, it is more significant than the interfacial-tension value as a gauge of contamination or oxidation.

Between interfacial-tensions of 20 and 40 dynes/cm, the relationship between specific concentration and interfacial-tension of "the oxidation products of (at least one) oil" can be described by the equation

$$C = \epsilon^{\frac{30 - IFT}{6.1}} \quad (2)$$

where C is the specific concentration, and IFT is the interfacial tension.

Interfacial-tension test is less sensitive than equation 2 would indicate at values either below 20 or above 40.

It can be shown that, providing the concentration of a polar compound in a nonpolar liquid is not too high, the relationship between p_o and concentration should be

$$p_o = p_o' + (20.4\, D^2/M - p_o')f \quad (3)$$

where p_o is the specific orientation polarization of the mixture, p_o' is the value for the pure nonpolar liquid, f is the weight fraction of polar component, and $20.4\, D^2/M$ is its theoretical specific orientation polarization at 25 C. D is the dipole moment in Debye units, and M is the molecular weight of the polar component.

The theoretical relationship is adequate for a mixture of t-butyl alcohol and transformer oil up to a p_o of 0.0150. At higher concentrations, the p_o of a mixture is smaller than predicted by equation 3.

The interfacial-tension test has not lived up to early expectations as an indicator of the sludging propensity of oil. When the interfacial-tension is low it is only a rough measure of concentration. Furthermore, the less aromatic, or more highly refined, transformer oils produce more lower molecular weight oxidation products to which the interfacial-tension test is more sensitive. The less aromatic oils however, do not produce sludge until they have been oxidized well beyond the point at which a lowly refined oil would start to sludge. Unless the nature of the original oil is taken into account, the interfacial-tension test would lead one to underestimate the sludging tendency of a highly aromatic oil, or overestimate the sludging tendency of a highly refined oil, or both.

The p_o of an oil before it has begun to deteriorate is a measure of the degree of refinement of the oil. A highly refined oil has a p_o value near -0.0010; a moderately refined oil has a p_o value near 0.0050.

At a given degree of oxidation a more aromatic oil would have a larger p_o than a highly refined oil. The increase in p_o is a measure of the degree of oxidation of an oil. Nevertheless, the p_o value of an oxidized oil is a better indicator of its remaining useful life than the increase in p_o. A highly refined oil can be oxidized to a further degree than a highly aromatic oil before the oxidation products have an adverse affect on the cooling of a transformer.

Any utility which is now measuring power factor and interfacial-tension of oil can determine p_o with very little additional effort. The density of the oil must be known in order to calculate the interfacial-tension value from the scale reading of a Du Nouy tensiometer. The dielectric constant can be calculated from the capacitance reading at the time the power factor of an oil is measured. Refractive index measurements can be easily and rapidly made.

A rough approximation of p_o can be obtained, without refractive index measurement, by assuming the p_d is 0.325 ± 0.005.

Three inhibited transformer oils were deteriorated in simulated service-oil life cells. In the very early stages of deterioration, there was a large drop in interfacial-tension. In the same time interval, there was no significant change in p_o. After the large early drop there was a further appreciable change in interfacial-tension only in the case of the most highly refined oil. Even though the highly refined oil had the lowest interfacial-tension at the cut-off point it had formed the least amount of sludge.

Since the amount of acids relative to other polar compounds formed during the oxidation of oil is dependent on the nature of the original oil and the conditions of deterioration, it is believed that the p_o test will allow a more accurate prediction of the remaining useful life of a transformer oil than the acid number test.

It is believed that field experience with the use of the p_o test will result in criteria that closely approximate the following, which are suggested by the results from simulated service tests:

1. Large fraction of original life remaining: $p_o < 0.0100$.
2. Small fraction of original life remaining: $0.0100 < p_o < 0.0150$.
3. Negligible useful life remaining: $p_o > 0.0175$.

Digest of paper 55-279, "Interpretation and Significance of Tests Indicating the Concentration of Polar Compounds in Transformer Oil," approved by the AIEE Committee on Transformers and recommended by the AIEE Committee on Technical Operations for presentation at the Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955. Published in AIEE *Power Apparatus and Systems*, August 1955, pp. 774–81.

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160,000-Ampere High-Speed Magnetic Amplifier

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ALTHOUGH RECENT LITERATURE has primarily described the small- to medium-power applications of the static magnetic amplifier, it is in the high-power field that the natural advantages of the magnetic amplifier can be fully realized. With present-day materials, the heavy-duty static magnetic amplifier can often be built smaller, more efficient, and less expensive than comparable rotating magnetic amplifiers.

This 160,000-ampere magnetic amplifier designed in 1950, and the largest static amplifier built to date, should serve as a model for the design of still larger magnetic amplifiers. In the equipment shown in Figs. 1 and 2, 12,800-volt 3-phase 60-cycle power was converted to 120,000 amperes direct current continuous and 160,000 amperes intermittent. The d-c output voltage was smoothly adjustable from 2 to 14 volts. The speed of response under double-power cycling was between $1^1/_2$ and 2 cycles. The amplifier control current was approximately 500 milliamperes for power outputs up to 2,040 kw.

The over-all efficiency of the magnetic amplifier was 82.9 per cent. While this represents a figure close to the ultimate efficiency of d-c magnetic amplifiers utilizing selenium cells, the advent of germanium and silicon power rectifiers has increased efficiencies to well over 90 per cent.

Because of the outdoor construction and the 12.8-kv supply voltage, the amplifier was oil immersed with oil to air heat exchangers. The magnetic amplifier and accessories weighed a total of 154,280 pounds. More than 20,000 pounds of copper were fabricated while the saturable reactors alone utilized over 4 tons of grain oriented steel. Eight-thousand gallons of oil were required to fill the system. The output of the magnetic amplifier was fed out through 12 one-half-inch by 12-inch water-cooled bus.

The electrical design represented a compromise between the allowable inverse selenium-cell rating, the maximum desired d-c output voltage, and the minimum total phase induction of the amplifier. The minimum phase inductance of the amplifier is largely that of the transformer, the saturated residual inductance of the reactors, and the inductance of the leakage flux encompassed by the lead loop between the transformer and the rectifier cells. Since the minimum inductance per phase causes a voltage drop directly proportional to the d-c output current, it is a major factor in determining the required transformer secondary voltage and inverse rating of the selenium cells.

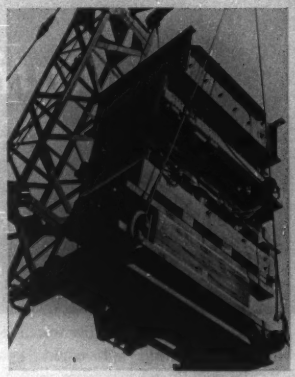

Fig. 2. Assembled unit hoisted for entanking

So 33-volt inverse cells were chosen with 17.1-volt transformer secondary voltage. Thus a single-unit 160,000-ampere amplifier would require a minimum inductance of not over 0.13 microhenry. This corresponds to a single-turn air coil approximately 12 cm in diameter, which is physically impractical. The inductive phase drop was reduced to 1.03 microhenries by using a 3-phase half-wave double-Y connection with an interphase transformer and building the amplifier in four parallel sections.

In order to overcome certain heavy-current connector problems, keep lead inductance to a minimum, and reduce the over-all bulk of the amplifier, a rather unique transformer-reactor assembly was evolved. The transformer secondary leads were made 40 inches long. The transformer was laid on its back with its secondary leads extended vertically. The reactors were designed for a 1-turn power winding and the reactor cores assembled around the vertical transformer leads. The ends of the transformer leads then connected directly to the rectifier stacks, with the result that the extended leads served the double duty of reactor power winding and rectifier to connector.

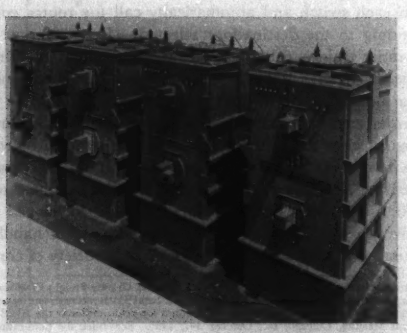

Fig. 1. Amplifier unit from output side

Digest of paper 55-61, "160,000-Ampere High-Speed Magnetic Amplifier Design," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Communication and Electronics*, March 1955, pp. 90–9.

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Automation for Freight Yards

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Recently developed speed-measuring and control systems automatically retard cars and guide them to classification tracks in modern gravity freight yards. A system is described in which cars establish and select their own releasing speeds derived from an electronic computer.

THE SIMPLEST and original form of freight-car classification yard is a group of parallel tracks, connected on both ends, on which a locomotive shuttles back and forth to sort cars into proper order before making them up into trains. Bringing mechanization and automation to this basic operation has been a step-by-step process.

Increases in freight traffic required faster sorting of cars and, in 1883, the first step was taken by placing one end of the yard on a rise or "hump." As a locomotive steadily pushed cars to the crest they were uncoupled and ran by gravity to the classification tracks. Brakemen rode the cars to prevent them from coupling at damaging speeds in the classification tracks. Other men were assigned the duty of operating switches along routes followed by the cars. Power-operated switches were introduced in 1891, permitting one man to control several switches. In 1924 car retarders, sometimes called rail brakes, were perfected and these have largely replaced the car riders.

A simple form of gravity yard designed for retarder operation is shown in Fig. 1 and its gravity profile in Fig. 2. The scale permits automatic weighing of cars as they roll down the grade. Gravity operation is now used extensively for major yards, but flat yards continue to be used for small volume sorting operations.

Automatic control of retarders to provide a fixed releasing speed was introduced in 1941 and expanded to provide multiple-speed selection in 1951. This scheme uses a series of short electric track circuits. When shunted by the wheels they detect the position of a car in the retarder. Speed is determined by timing the intervals between shuntings. Control of retarder pressure is derived from this operation and a release-speed setting chosen by the retarder operator.

The development of automatic-route switching in 1950 relieved the retarder operator of switch operation and permitted control, by one operator, of a yard with any practical number of tracks. Routes are established on a relay network by pressing destination buttons on a route-selection machine located at the crest of the hump. See Fig. 3. As the "cuts" (one car or several coupled cars) roll forward they are detected by track circuits associated with each switch and automatically call for routes corresponding to the destinations selected. Route storage for an entire train can be added to this system when circumstances warrant. Usually, the route machine is controlled by a member of the engine crew at the hump. Thus, the retarder operator has only the task of adjusting retarder pressure so as to (1) maintain enough separation between cars to permit switch operation, and (2) release cars at speeds required for safe coupling on the classification tracks.

Solutions under manual operation are developed intuitively by an operator from the experience of handling thousands of cars of various types under a variety of condi-

Full text of transactions paper 55-754, "Automation for Gravity Freight Classification Yards," recommended by the AIEE Committee on Land Transportation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 3-7, 1955. Scheduled for publication in AIEE *Applications and Industry*, 1955.

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tions. A pattern of release speeds is developed which will avoid having cars overtake each other thus going into the wrong track or coupling at excessive speeds. When the car weight information is reliable, manual control becomes an art at which the best operators develop a high degree of accuracy and consistency. To be economically justifiable, automatic operation must at least equal this performance.

A major step in the progress of yard automation was taken in December, 1954, when the Elgin, Joliet and Eastern Railway Company, Kirk Yard, Gary, Ind. inaugurated a system in which cars automatically establish and select their own releasing speeds, derived from a computing system which has been fed the necessary elements of information.

AUTOMATIC CONTROL PROBLEMS

As with manual control there are two basic interrelated problems which must be solved in automatic control:

1. Provide sufficient separation between the cars to enable them to be switched to the tracks selected by the automatic switching system.
2. Predict rolling resistance of individual cars or cuts to establish releasing speeds from the last retarder which will ensure safe couplings on the classification tracks.

The following factors affect the speeds at which cars should be released from the retarders and, therefore, the solutions to the problems:

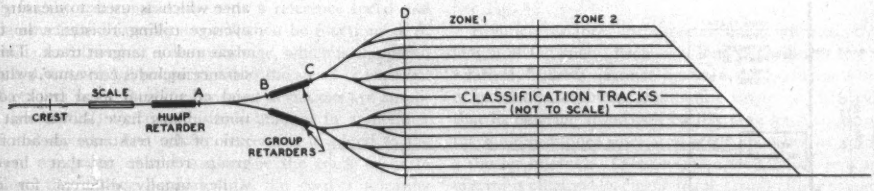
1. Factors associated with the yard design, which include: amount of curvature in route which car will traverse; special track conditions in the route such as low spots, tight gage, rough track, etc.; gradients along the route.
2. Variable factors, which include: special rail conditions such as rust, water, lubricants, etc.; wind direction and velocity; and the temperature.
3. Factors associated with the car or cut of cars, which include: overall rolling resistance of car including that caused by center plates and side bearings; car lading; car weight; and distance to the coupling point.

SOLUTIONS

The amount of separation required between cuts is a function of the shortest length of track circuit which cannot be spanned by the trucks of the longest car. Separation is obtained by increasing the speed of cars moving down the grade above that at which the cars move toward the crest of the hump. Separation speed (V_2) for the ideal case of uniform rolling resistance for all cars is:

$$V_2 = V_1(S+L_t)/L_c$$

where V_1 is the velocity approaching the hump crest, L_t



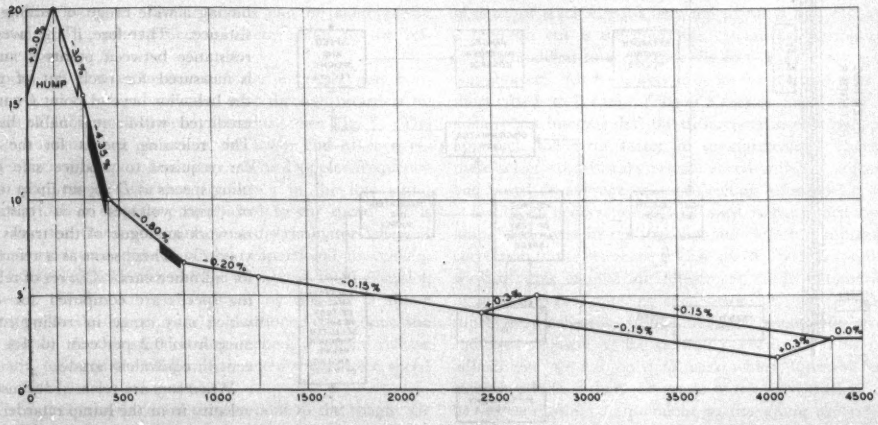


Fig. 1 (above). A simplified plan of small gravity freight yard with retarders and scale. Fig. 2 (below). The profile for gravity yard of the type shown in Fig. 1

Fig. 3. The push button panel for automatic selection of routes

the length of the detector track circuit, L_c the length of the car, and S the distance between first and last axles of the car.

V_1, the humping speed, is limited by V_2. When V_2 is the velocity leaving the last retarder, it in turn is limited by the maximum allowable coupling speed on the classification tracks. In order to keep V_2 and V_1 as high as possible, the grade beyond the last retarder must be nonaccelerating. This establishes the maximum release speed for easy-running cars.

It is apparent that if there is a wide range in rolling resistance between cars, there will be a tendency for easy-running cars to overtake hard-running cars in the area between the hump crest and the group retarder. Conversely, hard-running cars, released at relatively higher speeds to compensate, will tend to overtake easy-running cars between the group retarder and the last switch in the route. These two factors tend to be mutually compensating. By using only two points of retardation and releasing all cars at a uniform rate from the first (hump) retarder, the detrimental effect on the maximum humping speed can be minimized. In actual practice, the restrictions on humping rate resulting from spacing requirements are usually alleviated by the fact that there is random distribution of cars to the classification tracks and they do not, in general, follow adjacent routes, the most restrictive condition.

Uniform releasing speeds are obtained at the hump retarder by means of speed-measuring and fixed-speed selecting elements of the control system. Rolling resistance is measured and predicted with the organization of elements shown for a group retarder in Fig. 4. The characteristics of the tracks between points *A-B* and *C-D* (Fig. 1) are determined by means of a test car of low rolling resistance which is used to measure the average rolling resistance in those areas and on tangent track. This resistance includes curvature, switches, and all unusual local track conditions. Tests have shown that the ratio of the resistance ahead of the group retarder to that beyond, while usually different for each route, is relatively constant for cars having a wide range of rolling resistance. Therefore, if the average resistance between points *A* and *B* is measured for each cut of cars, the behavior beyond point *C* can be predicted within reasonable limits. The releasing speeds for the test car required to produce safe coupling speeds at *D* are set up in terms of direct voltages on a resistance network analogue of the tracks beyond *C*. These serve as a reference for all other cars. Curves of releasing speeds are computed for cars which may range in rolling resistance from 0.2 per cent to 1.4 per cent in equivalent grade.

When cars are released at constant velocity from the hump retarder the average rolling resistance between the hump and group retarders may

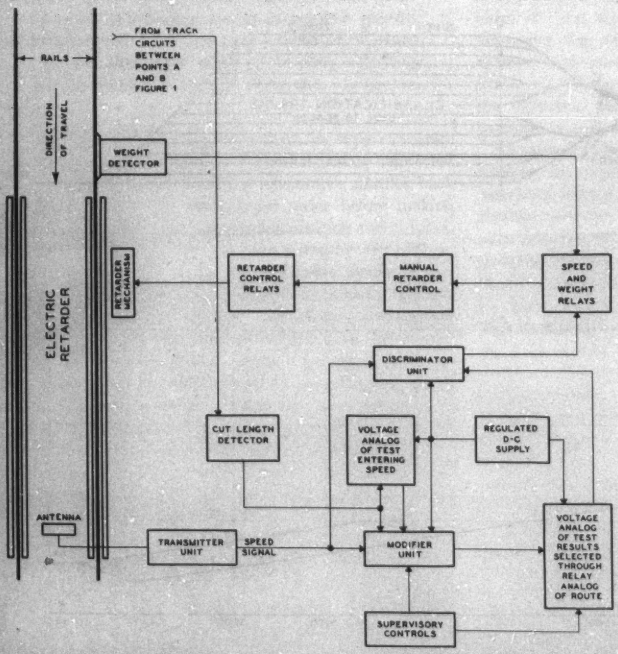


Fig. 4. Block diagram of the elements used in the automatic control of group retarders

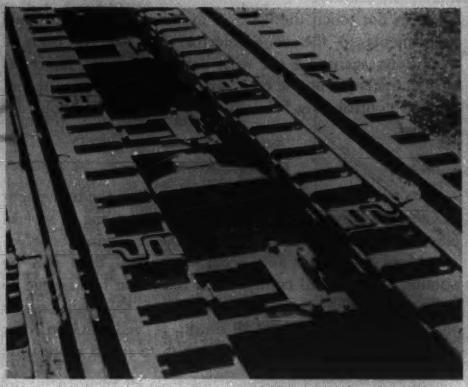


Fig. 5. Electric retarder with the radar antenna installed between the rails

Fig. 6. A retarder operator manipulating a supervisory control lever on the retarder control panel

be expressed as:

$$R=(-V_B^2/2g+K)/L$$

where V_B is the velocity of the cut as it reaches B, K a constant equal to the difference in elevation between A and B plus the elevation equivalent of V_A (the releasing speed at A), g is gravity, and L the length AB.

V_B for the test car can be made a reference speed and deviations from this reference will then be functions of R. Speed is established as a direct voltage, which is compared with a direct voltage proportional to the speed of each cut as it reaches point B. The resulting deviations are amplified (multiplied) by an adjustable amount in a modifier unit and stored. The voltage increment is added to the voltage appearing on the analog for the track so as to produce the voltage equivalent of the correct releasing speed. In cases where it is desired to make V_A variable for special purposes, similar results can be achieved by measuring V_A and transferring a correction to the reference speed at B.

Speed of cars is measured instantaneously and continuously as they approach and pass through retarders by means of 2475-mc Doppler-type radar. See Fig. 5. The radar antennas are placed in the lower end of each retarder facing the oncoming cars. The Doppler frequency shift produces a difference frequency in the low audio range which is directly proportional to car speed. It is fed from the transmitter unit to a discriminator where it is converted to a direct voltage proportional to velocity and compared with the voltage requested by the analog network. If the voltage produced by the car is above that requested, the retarder is positioned to reduce the car speed. As this speed is approached, a partial release is made, followed by a full release when the selected speed is reached.

The rate of retardation is proportional to the weight for a given retarder pressure. In order to secure uniform performance, the cars are placed in three weight classifications: light, medium, and heavy. These are obtained from an electromechanical device placed ahead of the retarder which weighs each wheel on one side of the cars and feeds the information to the control system. Retarder pressures are selected accordingly. These automatic speed and weight controls of retarder pressure are derived from relays in the output channels of the discriminator. See Fig. 4.

Rolling-resistance measurements are affected by the length of the cuts. Because a long cut will roll free for a relatively shorter distance between the positions A and B of speed measurements than will a single car, it is evident that its entering speed will be less than for a single car of the same resistance since it is acted upon by the grade for a shorter interval. Compensation for this inherent source of error is obtained by classifying the cuts in three categories: short, medium, and long. This is accomplished by means of detector track circuits between points A and B. When a medium cut is detected, the reference entering speed at A is modified to correct for the fact that the test section was shorter. Medium cuts may be from 2 to 4 cars, and short cuts 1 to 2 cars. Cuts of 5 cars or more have such a short test interval that the differences in entering speeds approach the error factor in measurement. Therefore, these select an arbitrary release speed which is adjustable and based on average values of rolling resistance.

Depth of penetration of the yard is controlled by the amplifying ratio in the modifier unit which computes the correction to the reference release speed. When conditions warrant, this can be an adjustment made automatically by counting cars entering each track. Usually a manual supervisory selection of two or three zones will provide sufficient adjustment for normal operations. This range adjustment applies only to cars which have a rolling resistance higher than the grade of the yard tracks. Cars having a resistance equivalent to the grade are released at the same speed for all depths of penetration.

Wind, temperature, snow, and rain can modify the over-

all operation. Compensation for these changes is available on a control lever which provides adjustments to the normal release speed settings.

Manual control levers with four positions are provided, as shown in Fig. 6. One position selects automatic operation and the others select retarder pressures which override automatic control. Associated with the group retarders are supervisory controls for selecting the zones of penetration. Controls are also available for each power switch so that the operator can select routes for reverse moves from the classification yard to the hump.

AUTOMATIC OPERATION

UNDER NORMAL CONDITIONS the string of cars being classified moves to the crest at constant speed and the retarder controls are in the automatic position. The retarder operator, located in a tower near the group retarders, watches the cars for unusual rolling conditions and for errors which may be made in the route selection. He does not touch the controls except to make occasional adjustments to the zone selector. In case of unusual conditions, such as a car with dragging brakes, failure of cars to uncouple at the crest, or too fast a humping speed, manual control may be used until normal operations are restored.

CONCLUSIONS

THIS SYSTEM for automatically controlling the movement of cars into classification tracks is now operating in several classification yards and produces the following benefits: (1) More consistent and accurate control than can be obtained by manual control; (2) reduction in damage to lading by minimizing unsafe couplings; (3) maintenance of high humping speeds at all times; (4) reduction in work strain on operator, which enables him to spend more time supervising the over-all operation; and (5) operations can be maintained during heavy fog conditions when cars are invisible to the operator.

Techniques for the Utilization and Modification of Encapsulating Resins

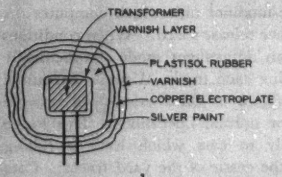
E. G. LINDEN PIERRE TOWNSEND

Electronic equipments and components subjected to conditions of high humidity, rough handling, and thermal shock require the use of encapsulating materials for protection. As each of these materials has its own special qualities, any one of them should be considered for a given application in accordance with the various characteristics, as described.

ELECTRONIC ENCAPSULATING MATERIALS include both organic and inorganic compositions used as impregnants, coatings, potting compounds, and embedding media for the protection and maintenance of electrical, physical, mechanical, and chemical characteristics of electronic equipments and components under conditions of high humidity, rough handling, and thermal shock. Table I lists some of these various materials, the specifications which they must meet, and some of their applications.

Each of these materials has special attributes which make its use desirable in a particular instance. There is no universal encapsulating material. Experience has shown that the type of material selected for a given application will vary with the service conditions and the characteristics of the item to be treated. Table II summarizes the applications of such materials and the reasons for their selection.

Table III lists the various methods of applying encapsulating materials and the means whereby they may be con-



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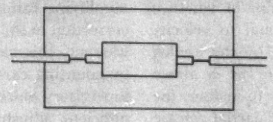

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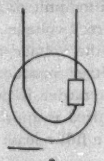

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Fig. 1. Cross section of embedded transformer. Fig. 2. Method of sealing electric leads against moisture. Fig. 3. Method of encapsulating transistor in hanging drop. Fig. 4. Potting of transistor in metal cup

trolled. In addition to these methods, there are commercially available equipments having automatically controlled mixing, distributing, and vacuum-impregnating units in one assembly for mass production.

The electrical, physical, and chemical properties of most of these types of materials are readily available from their manufacturers, and will therefore not be described.

Special techniques are sometimes required for the utilization of encapsulating materials, as described.

Fig. 1 shows an embedded transformer in cross section. The varnish immediately surrounding the transformer protects its electrical properties. The elastomeric layer permits the copper electroplate surrounding it to expand or contract under the influence of heat without rupturing. The copper electroplate (5 mils) is the moisture barrier protecting the transformer from humidity. The outer layer of varnish prevents corrosion of the copper.

Fig. 2 represents an embedded electric component which has been given a treatment designed to prevent moisture from traveling in by means of the insulating jackets on its electric leads. The insulation has been removed for a short distance so as to permit the embedding resin to adhere directly to the metal of the wire lead thereby setting up a block to the entrance of moisture by this path.

Fig. 3 is an illustration of one method of encapsulating transistors. When the electric leads have been placed in contact with the germanium crystal, a vessel containing catalyzed polyester resin is raised upward so that the assembly is completely immersed. The vessel is then lowered and removed from the assembly. The surface tension causes a hanging drop of resin to remain in place to be cured.

Fig. 4 shows another method of embedding transistors. The germanium crystal is placed in a metal cup having a perforating metal lead through its bottom. Catalyzed resin is then poured into the cup. The metal lid, which also has a perforating lead, is lowered onto the cup and adjusted so that proper contact is made. The resin is then polymerized, and the lid is soldered at its rim.

Another method of encapsulation utilizes a vacuum table having many perforations connected with a vacuum line. The objects to be embedded are placed on this table and a preheated thermoplastic resin sheet is placed over these objects. The vacuum line is then opened and the hot

Table I. Specifications and Applications of Metals

Class	Material Types	Specifications	Applications
Cast resins and elastomers	Drying oil Epoxy Polyester Polyvinyl formal Isocyanate *AN-5* Resin Furane Phenolic Polystyrene Thiokol Plastisols *NBS* Resin Silicone rubber	*MIL-C-16923A*, compound, embedding (for electronic equipment) *MIL-S-7502(USAF)*, sealing compound, synthetic rubber, catalyzed for internal fuel tanks *MIL-T-27(4)* transformers and inductors (audio, power, and pulse) *MIL-C-16558A*, coating, organic (for covering, struts, and other exposed surfaces) *MIL-C-15705A*, calking compound (liquid polymer polysulfide synthetic rubber; Formula 112 for metal enclosures) *MIL-P-77A*, plastic-material, thermosetting, cast; for use in electronic, communications, and allied electronic equipment	Coating, potting, impregnating, and embedding of electric cable connectors, circuits, junction boxes, and components
Hot melts	Microcrystalline and other waxes Bitumens Gutta percha Polyamide Polyethylene Polyisobutylene	*MIL-C-3301(1)*, compound asphaltic, hot melt (cavity lining) *MIL-W-13262 (ORD)*, wax, compound, tube potting *Federal Specification VV-W-95*, paraffin, technical *MIL-C-12557(SigC)*, compound, potting (Chatterton compound) *MIL-C-12762(SigC)*, compound, potting (bituminous plastic)*IC-1* insulating compound *MIL-C-2687* compound, battery sealing *MIL-S-3105*, sealing compound, inert (for use in ammunition)	Cable splices; ammunition; coating and impregnation of electric components
Mastics	Nonhardening putties, such as mineral-filled polyisobutylene liquid polymers Hardening putties	*MIL-I-3064*, insulation, electrical, plastic-sealer *MIL-C-16231A*, calking compound (for metal seams) *MIL-O-3134C*, deck covering (latex-mastic) *MIL-S-7126A*, sealing compounds, synthetic glass *MIL-O-7504(USAF)*, cement, sealing, general purpose, plastic	Junction boxes and cable connectors; sealing of radio chassis seams
Foam-in-place resins	Phenolics Isocyanate Silicone Epoxy	*MIL-C-8087(USAF)*, core-material, foamed-in-place, alkyd-isocyanate type, for aircraft structural applications *MIL-R-17354(SHIPS)* resin, phenolic, foamed-in-place	Electric circuits and components; airborne equipment
Inorganics	Castable ceramics	*JAN-R-717(2)*, refractory, castable, high-temperature, hydraulic-setting	High-temperature operation of electrical components
Greases	Silicone grease	*MIL-I-8660*, insulating and sealing compound, electrical	Cable connectors; ignition systems

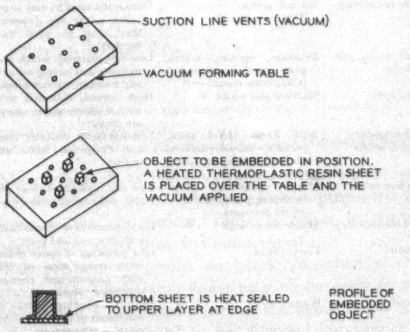
SUCTION LINE VENTS (VACUUM)
VACUUM FORMING TABLE
OBJECT TO BE EMBEDDED IN POSITION. A HEATED THERMOPLASTIC RESIN SHEET IS PLACED OVER THE TABLE AND THE VACUUM APPLIED
BOTTOM SHEET IS HEAT SEALED TO UPPER LAYER AT EDGE
PROFILE OF EMBEDDED OBJECT

Fig. 5. Vacuum-table embedment

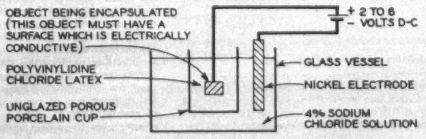
OBJECT BEING ENCAPSULATED (THIS OBJECT MUST HAVE A SURFACE WHICH IS ELECTRICALLY CONDUCTIVE)
+ 2 TO 6 − VOLTS D-C
GLASS VESSEL
POLYVINYLIDINE CHLORIDE LATEX
NICKEL ELECTRODE
UNGLAZED POROUS PORCELAIN CUP
4% SODIUM CHLORIDE SOLUTION

Fig. 6. Encapsulation by electrodeposition of plastics from latices

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thermoplastic sheet is formed around the objects to be embedded by the action of the vacuum. Each object is then trimmed with shears, and a thermoplastic sheet is heat-sealed over the bottom uncoated surface at the edges of the upper formed sheet. Fig. 5 illustrates this process, which is amenable to mass production.

In special cases, components having surfaces which are electrically conductive have been encapsulated by electrophoretic deposition of resinous materials from latices. Polyvinylidine chloride latices have been found to be suitable for this purpose. Fig. 6 illustrates this process.

Several methods can be utilized for decreasing the dielectric constant of an encapsulating material as the material can be foamed, or the material can be filled with hollow plastic or ceramic spheres of minute size.

Table IV lists the properties of systems of this type. It is to be noted that foaming a resin results in low values of dielectric constant, but that dielectric strength and arc resistance are also greatly decreased, which is undesirable. Phenolic hollow spheres in epoxy resin decrease the dielectric constant, with a moderate decrease of dielectric strength, but a large decrease in arc resistance occurs, which is undesirable. Hollow ceramic spheres in epoxy resin decrease the dielectric constant with moderate decrease in dielectric strength and practically no decrease in arc resistance. The dissipation factor is increased in epoxy resin when either hollow ceramic or phenolic spheres are used. It is believed that the latter effect would be decreased if hollow spheres made of the same material as the dispersion medium were used.

Table II. Special Applications of Encapsulating Materials

Application	Type of Material	Special Requirements
Cable connectors	Silicone grease Thiokol rubber	Compound must be easy to remove when cables are disassembled; they must be good moisture barriers
Cable splices, telephone	Bitumens, epoxies, waxes, gutta percha compounds (Chatterton compound)	Low-cost materials which are easy to apply and have good adhesive and moisture-barrier properties
Capacitors	Silicones and waxes	High corona, dielectric strength, and moisture-barrier properties are required
High-frequency applications	*NBS* Resin, *AN-5* resin, paraffin wax, polyethylene, cast polystyrene, isocyanate foam	Low-loss factor, dielectric constant, and dissipation factor are required
Junction boxes	Mastic compound, (non-hardening putty) and drying oil polymers	Low cost, moisture-barrier properties, and ease of removal
Radio-chassis seals	Mastic compounds	Good adhesion to chassis metal for sealing seams and ports
Resistors	Epoxy resins	Low shrinkage of epoxy resins prevents compression of resistors with concomitant changes in resistance values
R-f coils	Waxes	Maintenance of high-*Q* value under conditions of high humidity and variable temperature
Selenium rectifiers	Room temperature curing epoxies and polyesters	Some selenium rectifiers cannot be heated above 80 C without damage; room-temperature curing resin is therefore necessary
Transformers	Epoxy and polyester resins	Since transformers give off appreciable quantities of heat, they must be potted in materials which are capable of withstanding thermal shock
Transistors	Polyester resins	Thermosetting, room curing, transparent resins are occasionally used for embedding transistors for maintenance of positioning of electric leads
Vacuum tubes	Silicon elastomer	Vacuum tubes frequently operate at high temperatures and require shock mounting; silicone rubber has the requisite properties

Table III. Methods of Applying Encapsulating Materials to Electrical Components

Method	Materials Applied	Equipment Required	Control Methods
Casting	Inorganics Casting resins Hot melts Foam-in-place resins	Mixing equipment; molds made of chromium-plated metal, wood, glass, plastic, or cardboard; cardboard or plastic molds may be left on castings; metal, glass, or wood molds require mold release agents, such as bentonite dispersions or silicone grease to prevent adhesion of the casting; tinfoil may also be used as a release agent	Gel time Viscosity Exotherms Curing studies
Dip-coating	Varnishes Hot melts Casting resins	Melt or dip tanks	Temperature Viscosity
Vacuum impregnation	Hot melts Casting resins	Vacuum impregnation tank or vacuum desiccator	Viscosity Temperature Pressure
Flame spraying	Polyethylene or other thermoplastics	Plastic flame spraying gun	Flame temperature Rate of feed
Spatulation	Mastics	Putty knife	Plastometer
Centrifugal casting	Inorganics Casting resins Hot melts	Centrifuge	Velocity Cure
Brushing or spraying	Casting resins Hot melts	Brush or paint sprayer	Viscosity

Table IV. Techniques and Devices for Lowering the Dielectric Constant

Material	Dielectric Constant, 1 mc	Dissipation Factor, 1 mc	Dielectric Strength, volts/mil	Arc Resistance, seconds
Polyisocyanate foam	1.11	0.0065	70	70
Epoxy resin, "as is" basis	3.50	0.0288	360	121
Epoxy resin filled with 14.3 per cent by weight of hollow phenolic spheres	2.40	0.0314	160	61
Epoxy resin filled with 31.4 per cent by weight of hollow ceramic spheres	2.61	0.0861	122	118

Table V. Mechanism by Which Fire-Retardancy is Imparted

Material	Mechanism
Borates, such as methyl or zinc borate	Melts and forms a noninflammable coating on ignition, which excludes air
Antimony oxide	On ignition, this product melts and forms a coating which excludes the air from the fire
Calcium carbonate	On ignition, it forms CO_2 which dilutes the flammable gases produced to a concentration below the flaming point
Chlorine or bromine containing products, such as chlorinated polymers	On ignition, these form HCl or HBr, which dilute the flammable gases produced to a concentration below the flaming point
Phosphates, such as tricresyl phosphate, ammonium phosphate, brom allyl phosphate polymer, diallyl benzene phosphonate, triphenyl phosphate, trioctyl phosphate, octyl diphenyl phosphate	On ignition, oxides of phosphorus are produced, which dilute the flammable gases produced to a concentration below the flaming point

The flame-retardant properties of encapsulating materials for electronic equipment are frequently of major importance. These properties can be improved by the admixture of fillers of the type shown in Table V with the encapsulating material.

Casting resins can be converted to dip-coating types by the incorporation of 7 to 15 per cent of silica aerogel.

When a system is potted with a foamed resin, a layer of unfoamed resin is frequently applied to its outer surface to impart high arc resistance, dielectric strength, and impact resistance to the finished item.

It has been found that in order to be a good moisture barrier the encapsulating resin should have a thickness of 1/8 inch. Thinner coatings are generally unsatisfactory.

Insulation Aging Measured by Shearing Modulus

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A NEW METHOD is described for determining the effect of thermal aging on the shearing modulus of flexible sheet insulations by nondestructive tests using a torsion pendulum technique. The test sample consists of a 12-inch length of the material under test, clamped between two pairs of inertia bars of different weight and inertia.

Shearing modulus for the material is determined from the periods of the torsion pendulums and for each aging condition by using in the position shown in Fig. 1, and then inverting the test piece, thus interchanging the stationary and oscillating inertia bars.

Usually, the mathematics is relatively simple, but that for a thin strip becomes complicated. The torque produced by twisting a thin strip, where the ratio of width to thickness is greater than 100, is given by[1]

$$M=\frac{a^3bG\alpha}{3}\left[1+\frac{Eb^4\alpha^2}{120Ga^2}+\frac{\sigma b^2}{4Ga^2}\right] \qquad (1)$$

where

M = torque, inch-pounds
a = strip thickness, inches
b = strip width, inches
G = shearing modulus, pound/inch²
α = angular deflection, radians/inch (length of strip)
E = Young's modulus, pound/inch²
σ = strip longituindal stress, pound/inch²

By utilizing this thin strip in a torsion pendulum the shearing modulus of the test strip may be shown to be

$$G=\frac{1{,}920\pi^2IL-40ab^2T^2\sigma}{160T^2a^3b+T^2Pab^4\alpha^2} \qquad (2)$$

where

I = moment of inertia of inertia bar, inch-pound-second²
L = length of suspending strip, inches
T = times of oscillation, seconds
$P = E/G$

Fig. 1. Timing fixture permitting alignment in relaxed position and indexing of initial angle of twist

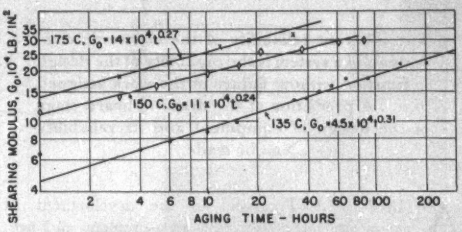

Fig. 2. Shearing modulus for black varnished cloth as affected by aging as calculated from torsion pendulum data

Unfortunately this equation involves the difference of two quantities of the same magnitude, so that the results may be subject to considerable error. Also, in the case of some nonisotropic materials, equations 1 and 2 do not give proper allowance for longitudinal stress. To overcome these difficulties the period of a torsion pendulum with zero weight (and hence zero σ) is calculated.

Fortunately, this may be accomplished by the use of a linear extrapolation involving the kinetic energies of the two pairs of inertia bars as a function of the weight of the bars. Including this extrapolation for small (15°) deflections, equation 2 becomes

$$G_0=\frac{12L\pi^2m_1m_2}{a^3b(m_2-m_1)}\left[\frac{I_1}{T_1^2m_1}-\frac{I_2}{T_2^2m_2}\right] \qquad (3)$$

where

G_0 = shearing modulus with zero longitudinal stress, pound/inch²
m = weight of pendlum, pound
Subscripts 1 and 2 refer to lighter and heavier pendulums, respectively

Materials such as black varnished cloth, polyethylene terephthalate (Mylar), and glass cloth impregnated with silicone rubber or varnish show increases in shearing modulus with aging time and temperature.

The preliminary results on black varnished cloth as given in Fig. 2 indicate a linear relation between shearing modulus and a fractional power of the aging time. Data of this type are believed to be of major importance not only as aging criteria but they are also related to such basic characteristics of apparatus as short-circuit strength.

REFERENCES

1. Strength of Materials (book, pt. 2), **S. Timoshenko.** D. Van Nostrand Company, Inc., New York, N. Y., 1941, pp. 298–304.

Digest of paper 55-35, "Insulation Aging Characteristics as Measured by Shearing Modulus," recommended by the AIEE Committee on Basic Sciences and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Communication and Electronics*, May 1955, pp. 232–9.

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Prediction of Electronic Equipment Reliability

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The inherent reliability of the electronic components of a system is the capability of the design to function without failure in the work assigned to it. A prediction at the drawing-board stage of the design of equipment and its reliability can be made.

AN IMPORTANT aspect of the development of techniques for quantitative measurement and prediction of the inherent reliability of electronic equipment is a method for predicting its reliability in the drawing-board stages of its development. Since this prediction is based on design factors which can be seen on the drawing boards, it is referred to as inherent reliability. Inherent reliability may be considered as the capability of the design to operate without failure in its assigned task. This is in contrast to operational reliability which is concerned with the over-all man-machine system.

Reliability is basically a probability—the probability of successful operation during a given task. The work under discussion has been concerned with naval shipboard equipment where an equipment's task may require it to operate successfully for periods of time well beyond a reasonable probability of no-failure operation. For this reason, it has been found more convenient to use equipment failure rate or inversely, mean-time-between-failure as a measure of the equipment's reliability.

Prediction of mean-time-between-failure requires adequate data describing experience. Although experience data may be satisfactory for establishing basic relationships between design and failure rate, it is history and, therefore, at least one step behind the state of the art. If the growth of the electronic technology is accepted as being essentially evolutionary in nature, then data on the most recent experience can provide a reasonably good basis for prediction. The prediction method described is based on a permanent Navy system of data collection so that recent data is always available.

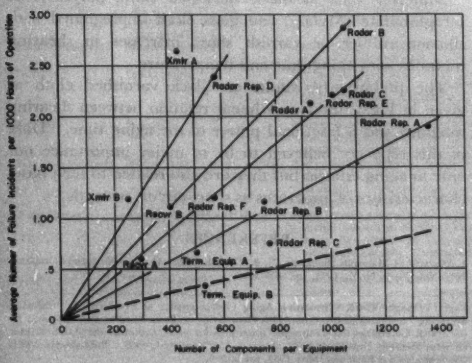

Fig. 1. The failure incident rate is plotted against the number of components in several pieces of electronic equipment

These data are the Bureau of Ships Electronic Failure Reports which are submitted by a Navy technician for each electronic component replaced during an equipment repair. These data are known to have several shortcomings. They are somewhat incomplete; they display some selectivity in reporting among the various components; they include nonfailing components replaced during maintenance; and, they do not contain the equipment operating time during which replacements occurred. It is estimated that 43 per cent of the total replacements are being reported: 52 per cent of tube replacements, 32 per cent of resistor and capacitor replacements, and 20 per cent of other component replacements.

These estimates are based on a comparison of the Navy reported data with data from an extensive field program by engineers who observed equipment operation aboard 7 aircraft carriers, 11 destroyers, 6 submarines, and at 3 shore stations. More than 700 equipments involving 15 equipment models were observed for almost one-half million equipment operating hours. During this time, almost 800 equipment failure incidents were recorded—a good representation of the types of failure experienced by the 15 equipment models. The field data provided correction factors which were applied to the Navy data and permitted the use of the large volume of Navy data for developing prediction guide lines.

SCOPE OF NAVY DATA

AN UNDERSTANDING of the scope of the Navy data may be obtained by reading figures. For the same 15 equipment models observed in the field, 1 year of reporting has yielded almost 45,000 reports on more than 6,000 equipment serial numbers. It has been estimated that these data represent almost 22,000 equipment failure incidents. It is evident that these data, when properly supplemented, can provide a good reflection of field experience.

The approach to the development of prediction guide lines has been to determine a measure of the reliability of the 15 equipment models and to correlate their differences in reliability with design factors that can be seen on the

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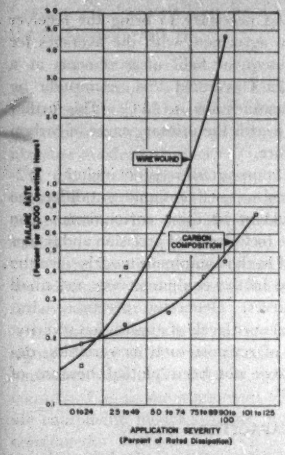

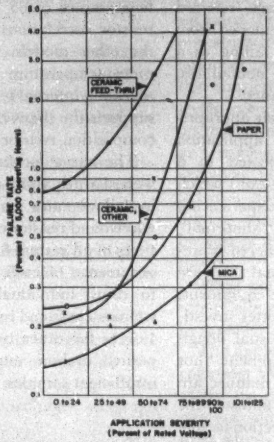

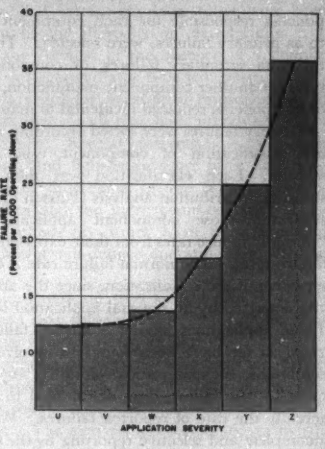

Fig. 2 (left). The failure rate is plotted against the per cent of rated dissipation of wirewound and carbon resistors. Fig. 3 (center). The failure rate is plotted against the per cent of rated voltage of different types of capacitors. Fig. 4 (right). The failure rate is here shown plotted against some types of vacuum tubes

drawing board. Fig. 1 represents an attempt at correlating equipment failure rate with the number of components contained in an equipment. The average number of failure incidents per 1,000 hours of operation for each model is plotted against the number of components per equipment. Radial lines are drawn through the origin to represent equal levels of failure rate per component. The fact that several equipments group themselves along one radial indicates the strong influence of the number of components on the equipment's reliability. However, the fact that all equipments do not lie along a single radial shows that other important factors need to be considered. The influence of environment as a factor has been discounted. The equipments are widely distributed throughout the fleet and each model is subjected to the full range of shipboard environment. No evidence has been found that indicates that the relative age of these equipments is an important factor.

Attention is directed toward several of the equipment models in Fig. 1. Radar *C*, for example, is an improved version of Radar *B;* Radar Repeater *C* is also an improved version of Radar Repeater *B*. In each case, known areas of unreliability in the older equipment have been redesigned with the reliability improvement shown in the figure.

Of interest also is a comparison between Terminal Equipment *A* and Terminal Equipment *B*. These two equipments are identical in every respect but one; Terminal Equipment *B* has blowers, whereas Terminal Equipment *A* does not. The improvement of almost 2-to-1 in reliability of an already highly reliable equipment is a startling demonstration of the effect of temperature on equipment operation. It is apparent that the differences in reliability between the equipment models shown are primarily attributable to differences in equipment design. These design differences become evident in their effect on the useful life of the components.

The investigation, therefore, has been concerned with a detailed analysis of the design application of the most common components found in the equipments. The relationships which will be described are based on the analysis of component applications in seven of these equipment models. This analysis involved a total of 2,552 applications of which 276 were electron tube, 1,484 were resistor, and 792 were capacitor applications. These analyzed applications represent a field population of almost $1^1/_2$-million components—more than 100,000 electron tubes, 700,000 resistors, and almost 600,000 capacitors.

ELECTRONIC COMPONENTS ANALYZED

THE ANALYSIS has been primarily concerned with electron tubes, resistors, and capacitors, since these components represent approximately 75 per cent of all components found in electronic equipment and account for most of the equipment failures. The procedure was to classify these components by type and by the severity of their application and to correlate each classification with its failure rate. Severity of application was based on one or more design factors which were believed to have a major influence on the life of the component. The design factors selected will be discussed in connection with the individual component correlations.

The failure rates are based on tabulations of the Bureau of Ships Failure Reports as qualified by field data. The determination of the failure rate for each component classification was an important aspect of the work. Component replacements as reported in the Navy data were grouped into equipment-failure incidents, and the com-

ponents responsible for each equipment failure, referred to as primary failures, were selected. This removed from the data secondary failures, or components failing as a result of another component malfunction, and nonfailures, or components replaced incidental to maintenance.

Primary failures were sorted according to their appropriate classification of component type and application severity. Each classification was then subjected to a statistical distribution analysis (Poisson distribution) which separated those component applications experiencing "normal" failure rates from those experiencing "abnormal" failure rates. The normal failure rate is considered representative of the classification, since the abnormal rates are characterized by an unusual application in the equipment. Those applications having abnormal failure rates investigated so far have been found to involve unusual design conditions, such as critical circuitry, or equipment "hot spots." The failure rates determined in this manner are actually the rate of reported failures. When adjusted for incomplete and selective reporting by the correction factors determined from the field data, they are a reasonably good estimate of failure experience.

RESISTORS

LOGICAL RELATIONS between failure rate and application severity have been obtained. Fig. 2 shows the failure rates for fixed composition and wirewound resistors versus application severity.

Heat is considered to be the primary factor contributing to the failure rate of resistors. In these correlations, the application severity is based on the power dissipation of the resistor as the main source of heat affecting their life. Although an internal equipment temperature of less than 40 C is assumed, these correlations should retain their comparative value if the internal temperatures of the equipments are essentially in the same region, even though they may be above 40 C. The equipment models considered appear in large numbers in the fleet and each model as a class is subjected to the full range of shipboard temperatures; the variations in failure rate between models can not be attributed to specific shipboard temperatures. Variations in internal temperature-rise between equipment models, if significant, may affect a comparison of their normal component failure rates. Equipment hot spots usually result in an abnormal failure rate for the component affected, and these components, as previously explained, have been removed from the correlations. Spot temperature checks in the field indicate that with the exception of one equipment model, a uhf receiver, variations in internal temperature-rise for the models considered in this article are not significant.

Resistors in the receiver had an appreciably higher reported failure rate for each application severity level than those in other models. Since this model had no provision for ventilation, the failure rate was attributed to a high internal equipment temperature. In fact, spot component body-temperature measurements indicated that resistors in this equipment were operating at a higher temperature than resistors in the other equipments. A derating factor corresponding to an assumed internal temperature of 65 C was necessary to bring the receiver resistor correlations into agreement with the averages for the other models. Subsequent field measurements at a room temperature of 25 C verified this assumption by revealing internal temperatures of 61 to 68 C. This further supports the thesis that heat is the primary cause of carbon composition resistor failure.

The curve for fixed composition resistors includes 1/2-watt, 1-watt, and 2-watt sizes since no significant difference in failure rates was evident in these correlations. The wirewound resistor curve includes fixed precision and power types of all ratings found in the equipment models since the occurrence of each type in the equipment was too small to draw individual curves. Generally, precision wirewounds are found in the lower levels of application severity. Curves for other types of resistors such as variables, deposited carbon, etc., have not been plotted because of insufficient samples.

CAPACITORS

THE FAILURE RATES for mica, paper, feed-through ceramic, and other ceramic capacitors versus levels of application severity are shown in Fig. 3. Other types of capacitors have not been included because of insufficient samples.

The voltage impressed across a capacitor is assumed to be the major factor influencing its life. Although the relation between voltage and capacitor life is complex, including considerations of amplitude, polarity, frequency, and wave shape, several simplifications, which reduce application severity to a convenient statement of voltage amplitude, have been adopted. These simplifications, consistent with current design practice, apply particularly to d-c rated capacitors. Essentially, they consist of treating the peak-to-peak values of a-c voltages and pulsed voltages as a d-c voltage. In all cases the application severity is the ratio of the applied voltage, or equivalent applied voltage, to the rated voltage in per cent. As in the case of resistors, field environmental conditions are not considered since they apply equally to each equipment model.

TUBES

THE FAILURE RATE of selected tubes versus their application severity is shown in Fig. 4.

It was found that the application severity of electron tubes could not be based on a single design factor as in the case of resistors and capacitors. After several trials, a combination of electrode voltage, current, and power dissipation, with the latter being the most influential, was found necessary to determine the application severity of tubes. The six levels of application severity adopted are:

Operating Level Class	Voltage, Current, and Power Levels for Tube Elements
U.....	All voltages and currents less than 50 per cent of rated values, and power dissipation of all elements less than 25 per cent of rated values.
V.....	All voltages and currents less than 75 per cent, and power dissipation of all elements less than 50 per cent.
W.....	All voltages and currents less than 90 per cent, and power dissipation of all elements less than 75 per cent.
X.....	All voltages and currents less than 90 per cent, and power dissipation of all elements less than 90 per cent.
Y.....	Any voltage, current, or dissipation level greater than 90 per cent but less than 100 per cent.
Z.....	Any voltage, current, or dissipation level greater than 100 per cent of rated level.

Certain qualifications have been observed in determining the application severity:

1. Rated voltage, current, and power levels were taken as "design center" values, as listed in the manufacturer's tube handbook, rather than "absolute maximum" values; the design center values are normally 90 per cent of the absolute maximum values.

2. A high screen-grid power dissipation level was disregarded if the sum of the plate dissipation and the screen dissipation was less than 90 per cent of the sum of the rated values.

3. The heater-cathode voltage was not considered since the failure reports were not sufficiently detailed to associate failures with this factor.

4. In all models studied, the heater voltages were designed to be within the specified limits. Power source variations which affect the actual heater voltage may be considered as an environmental effect applying equally to all equipment models. Thus, heater voltages were not considered.

Receiving-type tubes, including diodes, triodes, pentodes, beam power tubes, low-voltage (less than 1,500 volts) rectifiers, and low-power thyratrons, have been considered in the present correlations. One tube usually classed as a transmitting tube, type *807*, was also included because its construction and characteristics are similar to receiving-type tubes. Gas-filled voltage-regulator tubes have been excluded because of the difficulty in determining true operating levels and because of the absence of a definite failure region; a voltage-regulator tube will cease to function properly as a regulator because of improper circuit levels, even though these levels may have no adverse effect on the life of the tube. Special receiving-type tubes such as klystrons, acorn, and lighthouse tubes have also been excluded because of differences in the failure patterns between these tubes and the more common types of receiving tubes. Cathode-ray tubes have been excluded because of the lack of a well-defined operating level for such tubes.

These correlations indicate that a reduction in failure rate of almost 3-to-1 may be achieved in many applications by considering class *W* as the design center.

The analysis confirms on a quantitative basis what most engineers have suspected on a qualitative basis—that reliability depends strongly upon the severity of the components' application. The analysis was concerned primarily with shipboard equipment. Additional design factors may require consideration under more or less severe environments. The component failure rates may be very different under other environmental conditions. However, it is believed that the technique described is applicable to other equipment and environmental situations and will permit the establishment of prediction curves for these situations.

Thumb-Size Motors Developed for Aircraft Applications

A tiny motor, no larger than a man's thumb, has been developed by the General Electric Company's instrument department at Lynn, Mass., for aircraft applications as well as for use in the gyro component of the *MA-1* compass-controlled directional gyro-compass system. Engineers predict that designers of aircraft instruments and servo systems will find it can be adapted to many uses.

Rated at 26 volts and weighing just 1.2 ounces, it is 5/8 inch in diameter and 1.2 inches long. Its no-load speed is 21,000 rpm, and it has exceptionally high acceleration, stall torque, and efficiency for a motor of its size and type. It is designed to withstand ambient temperatures in the range of −55 to +90 C when operated as a control motor, and is built to provide satisfactory performance at altitudes up to 60,000 feet.

This 2-phase, low-inertia servo motor may be used in a wide variety of circuits to make possible accurate null-method measurements, as well as to provide the power required to initiate control. In one of the simplest of these circuits, one phase of the motor is continuously excited from the 400-cycle line, while the other is fed from the output of a servo amplifier. The necessary 90° phase shift between the input to the fixed phase and the variable phase may be introduced in the error signal circuit, in the amplifier, or in the fixed-phase circuit. In this way, the error signal from a synchro-control transformer may be amplified and used to initiate control through the servo motor.

A New Temperature Relay for Use with Resistance Temperature Detectors

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A wattmetric induction unit, similar in construction to a watthour meter, is the sensitive relay element of this temperature measuring circuit, which provides protection to electric equipment so that maximum-temperature limits are not exceeded. Advantages of the relay include simplified design, accuracy, and reliability.

THE PROTECTION of large motors, generators, and power transformers against damage requires the use of many automatic devices which respond to a variety of abnormal conditions within the equipment. One form of damage is insulation failure caused by sustained operating temperatures above normal. In high-capacity units particularly, small variations in cooling conditions can result in accelerated insulation deterioration. It is therefore advantageous to provide means for continuously monitoring hot-spot temperatures which will perform a remedial function when the safe limit is exceeded. A new and improved form of temperature relay has been designed to detect more accurately a specified temperature condition within the protected apparatus.

Adequate protection of equipment is a necessity where large capital outlay and dependability of service are vested in the equipment. In general, Resistance Temperature Detectors (RTD) are available for turbine generators above 500 kva, and for other apparatus in the 1,000- to 1,500-kva class and above. These resistance elements are used with meters and recording devices, as well as with protective relays as a means for indicating temperatures at selected points within the apparatus windings.

The function which a temperature relay performs depends on the type of equipment, its importance in the system, and its location. In unattended stations the relay may be used to reduce or remove machine load automatically, and to prevent increase in load until machine temperature has decreased to normal. Under no circumstances, however, should the relay be used to determine machine load, since operating temperature is not necessarily a reliable indication of maximum permissible load. Other limitations may place more stringent restrictions on machine rating.

In attended stations, the function of the relay is generally to give warning of an "overtemperature" condition, particularly in the case of major units and essential auxiliary power equipment. The circuit may be arranged to sound an alarm, and at the same time initiate a timing device which causes delayed automatic corrective action if the station operator has not responded to the alarm within a reasonable time. The temperature relay may also be applied directly to the trip circuit of circuit breakers associated with a power transformer. An overtemperature condition will then cause the transformer to be removed.

The new design of temperature relay is arranged to respond to an adjustable temperature which represents the alarm or trip point for the protected equipment. This is in terms of maximum permissible temperature in lieu of a specified rise above ambient.

A survey was conducted among machine designers to determine what temperature measurement would offer the highest degree of protection. The present thinking is that the best compromise is an actual winding temperature measurement, the limit of which can be set to meet long-term trends in ambient temperature. Where extremes between ambient and operating temperature might cause damaging mechanical stresses, the relay operating point can be set to a lower level. Fig. 1 illustrates the new relay with its calibrated adjustment over the range of 80 C to 120 C. With this range, pickup may be set to meet temperature-rise limitations in low-ambient areas or maximum-temperature limits in areas of controlled ambient for either Class *A* or Class *B* insulation.

RESISTANCE TEMPERATURE DETECTOR

IN LARGE MOTORS and generators, it is common practice to embed several noninductively wound copper resistors adjacent to and insulated from the load-carrying windings. In power transformers, resistance elements are used in conjunction with simulated winding hot-spot temperature equipment. These resistors generally have the value of 10 ohms at 25 C and, being copper, vary in resistance according to the temperature of the surrounding medium. The relation between resistance R_t of a standard RTD in ohms and its average temperature t in degrees centigrade is given by

$$R_t = 9.04 + 0.0385t \qquad (1)$$

By the use of circuits which respond to the resistance of the RTD, the temperature of the equipment is indicated at selected points. A temperature relay utilizes the change in resistance of an RTD to perform its protective function. It normally uses the RTD showing the highest temperature under operating conditions.

The accuracy with which the RTD reflects the apparatus winding temperature has been recently discussed concerning hydrogen-cooled generators.[1,2,3] A certain amount of error arises from the cooling effect of the hydrogen gas at

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the edges of the RTD, and from the increased temperature drop across the winding insulation. The over-all result is a lower average RTD temperature than in the case of air-cooled machines where the heat transfer between winding and coolant is less efficient. On the basis of information presented for hydrogen-cooled machines[1,2] and simple tests, a correction factor dependent upon machine loading, but independent of hydrogen pressure, can be determined which enables a suitable setting to be chosen for a protective relay operating in conjunction with an RTD.

RELAY DESIGN REQUIREMENTS

Based on the common practices followed in applying temperature relays, certain functional and performance specifications were set up as minimum design limits. To provide for the control functions required of the relay, particularly at unattended stations, the circuit must contain both normally open and normally closed contacts. These contacts must be actuated when the relay detects an over-temperature condition in the protected equipment, and must remain in the operated position until the equipment temperature has fallen to a safe value. The most desirable differential appears to be 10 C. Therefore, over the required range of pickup of 80 C to 120 C, a release or restart indication must be supplied at 10 C less than the chosen pickup setting. In cases where the relay is used to sound an alarm, a further signal may be desired when normal temperature is restored. Some applications require direct tripping of a circuit breaker. Here a seal-in unit is necessary to protect the relay contacts.

To provide identification of the relay as the device which caused a tripping operation or alarm, a target indication is required. Where the control of restarting is employed, it is permissible to use a voltage-operated target device. In direct tripping applications, the target is preferably operated by trip current in conjunction with seal-in relay action.

The relay is inherently a sensitive device in that it must detect changes in resistance in the order of 0.05 ohm. It is required, however, that shock susceptibility be low enough that there be no danger of false operation when the relay is mounted in the conventional manner on instrument panels. Station vibration and accidental shocks must not cause the relay to operate incorrectly. In addition, contact pressures must be great enough to provide action.

To maintain accurate temperature protection of important apparatus, it is required that the relay pickup points be held to within 2 per cent of the calibration adjustment setting over the entire adjustment range. Errors caused by ambient-temperature variation in the relay location must likewise be held to a minimum.

RELAY CONSTRUCTION AND CIRCUITRY

The basic requirement that the relay detect a change in resistance of 0.05 ohm arises from the desirability of using a standard RTD as the temperature-sensing element. The fact that a 10-ohm copper wound resistance is employed establishes the need for measuring a 0.5-per-cent change in resistance. In addition, a limitation is imposed on the permissible current which can be passed through the standard RTD without introducing errors from self-heating. The combination of these facts dictates that a sensitive relay element be employed. The wattmetric induction unit, similar in construction to a watthour meter, can be employed satisfactorily to meet the sensitivity requirements and at the same time provide maximum resistance to faulty operation from shock. The torque exerted upon the disc of this unit is dependent upon the magnitudes of the currents in the polarizing and operating coils as well as the phase angle between them. For each of several resistance-measuring circuit arrangements considered, an analysis was made to determine the optimum coil designs to obtain maximum torque. The problem is similar to that of matching a generator (the resistance-measuring circuit) to its load (the operating coil) for maximum power transfer, but is complicated by consideration of the phase angle of operating current with respect to polarizing current.

The elimination of ambient-temperature compensation from relay performance characteristics permitted a considerable simplification in relay construction as well as application. Where compensation was provided in the past, it was necessary to mount a mechanically rugged ventilated resistor box in the cooling-air intake-port of the machine. The resistors in this box were calibrated and serialized with the relay. It was necessary for the user not only to mount and wire the auxiliary resistor box, but to check calibration when a substitute relay was used. In addition, ambient compensation would allow excessive temperatures to persist where the cooling medium failed.

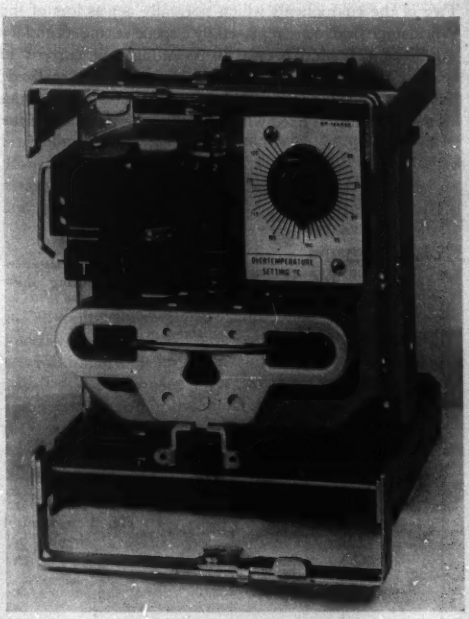

Fig. 1. Temperature relay

The new design of temperature relay places all parts of the relay circuit in one package of the size of a time-over-current relay. Independence of calibration from ambient-temperature change is achieved by the use of low-temperature-coefficient circuit elements, and a circuit arrangement which tends to cancel residual variations.

Fig. 2 illustrates the improved circuit for measuring the change in resistance of the RTD. The circuit is similar to a Wheatstone bridge except that two adjacent legs of the conventional bridge are replaced by transformer secondary windings. A voltage is induced in each of these windings which acts as the excitation voltage to the bridge circuit. With equal induced voltages and balanced resistances in the remaining two legs, equal currents will circulate around the upper and lower loops, and the current in the operating coil will be zero. An increase in RTD resistance will decrease the current in the upper loop and cause current to flow in the operating coil. This current establishes a flux which reacts with the flux from the polarizing coil, and produces a torque tending to close the left contacts of the wattmetric unit. When the RTD resistance increases sufficiently, enough torque will be produced to overcome the opposing torque and cause contact closure.

The transformer which provides the bridge-circuit excitation is conveniently derived from the wattmetric-unit polarizing coil and magnetic circuit. A center-tapped secondary winding is placed on top of the polarizing coil. The number of turns are selected so that bridge excitation voltage does not cause current to flow in the RTD which is so high as to produce self-heating. This method of excitation has four distinct advantages: (1) Two of the components which normally act as legs of the Wheatstone bridge are replaced by a space-saving secondary winding. (2) An increase in operating coil current of nearly 2-to-1 for a given unbalance of the bridge is realized; this arises from the fact that the potential of the center tap on the secondary is fixed with respect to the potential of the top and bottom of the bridge regardless of unbalance current flow. (3) The bridge circuit is electrically isolated from any other circuit, and no problems of multiple grounds can arise; standard practice is to ground one of the RTD leads at its terminal point on the generator. (4) The most notable advantage is that the excitation voltage to the bridge can be adjusted to the proper value by controlling secondary turns, thereby eliminating the need for wasting power in a series resistor mounted external to the relay.

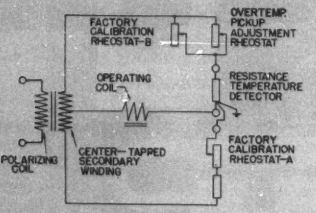

Fig. 2. Resistance-measuring unit

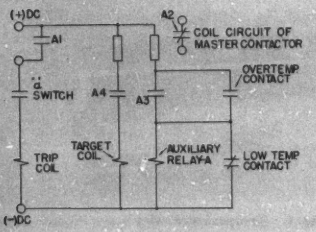

Fig. 3. Control circuit

Calibration of the pickup adjustment is accomplished in two steps. With minimum resistance in the pickup adjustment rheostat (120 C setting), calibration rheostat *A* is set to give pickup with an external resistor simulating the RTD at 120 C. Then, in order to match the change in pickup adjustment resistance to the desired spread in RTD temperature, this adjustment is set on the 80-C mark, the external resistor is changed to simulate the RTD at 80 C, and calibration adjustment *B* is set to give pickup. The linearity of the resultant relay pickup versus pickup adjustment setting is not impaired because of the ratio of approximately 10-to-1 between resistance of the calibration rheostat *B* and the pickup adjustment rheostat.

The 10-C differential is set by adjusting the gap between the two fixed contacts of the double-throw contact arrangement. This adjustment is conveniently made by moving the mechanical supporting member for the back, or low-temperature, contact until contact closure is obtained when the simulated RTD resistance is 10 C below the pickup setting.

One form of the control circuits is shown in Fig. 3. These circuits can be arranged to operate from a d-c source, or from the alternating voltage supply to the polarizing coil. External-circuit controlling contacts *A1* and *A2* are actuated by auxiliary relay *A*, which is of the telephone type. Relay *A* is energized through a series resistor by the closing of the overtemperature contacts of the resistance-measuring unit shown in Fig. 2. Contact *A3* seals the relay so that it remains operating after the overtemperature contacts open as the protected apparatus cools. After a predetermined decrease in temperature, the low-temperature contact of the resistance-measuring unit closes, thereby shorting the coil of the relay *A*. The relay drops out, and circuits controlled by contacts *A1* and *A2* are restored. In this way a lockout function is provided during the cooling period of the apparatus. When the protected apparatus is first energized, the low-temperature contact of the relay will be closed, and will remain in this position until the apparatus reaches the operating temperature.

With this circuit there is also provided a voltage-operated target. This is energized by contact *A4* of auxiliary relay *A*. Once energized, the coil causes a distinctive flag to be latched into a visible position to indicate that the relay has operated.

In models where the low-temperature indication is not required, the auxiliary relay *A* and low-temperature contact are omitted, and the overtemperature contact is placed directly in the trip circuit. Here the target mechanism acts also as a seal-in relay to short around the overtemperature contact.

To decrease the sensitivity of the measuring unit to shock, a damping or drag magnet made of high-strength magnet material is placed around the disc. The magnet causes eddy currents to flow in the disc whenever there is relative motion between the two. These currents cause energy dissipation in the disc itself and are very effective in keeping disc movement under the impulse of a shock to a minimum. The drag magnet eliminates the need for any external time delay to be inserted into the control circuits to ride over the effects of shock on an undamped measuring unit.

RELAY PERFORMANCE

EXTENSIVE TESTS have been performed on two sample relays. These tests included checks on the accuracy of the pickup adjustment rheostat, the variation in pickup with supply voltage and frequency, the variation in pickup over a range of ambient temperature within the relay, the temperature rise of various components within the relay, the constancy of closing point of the low-temperature contact versus pickup setting, and the magnitude of contact closing force per unit unbalance of the bridge.

Fig. 4 shows a calibration curve versus pickup adjustment-rheostat dial setting. The maximum error in both samples occurs at 105 C, and is equal to 1.1 C. It should be noted that the tests were conducted without having made a close calibration of the end points. Greater accuracy in the calibration would reduce the maximum error. The error arises from several factors as: (1) the nonlinearity of rheostat resistance winding; (2) the small effect of the calibration rheostat *B;* and (3) the human factor in setting the dial pointer.

Variation in pickup with supply voltage is shown in Fig. 5. In the range surrounding the relay rating of 120 volts, the variation is 0.15 C per volt change. A ± 5-volt change causes a minus or plus change in pickup of less than 1 C.

Frequency changes have a small effect upon pickup as shown in Fig. 6. The variation is linear with a negative slope of 0.11 C per cycle per second change in frequency. For all normal applications this change is negligible.

The temperature of the elements of the bridge circuit and the measuring unit itself has an effect upon pickup of the relay. For a change in the internal temperature of the relay from 40 C to 70 C, the variation in pickup of the relay is approximately 1.5 C in a positive direction. The magnitude of this change has been kept at a minimum by arranging the circuit so that the total resistance change in both legs of the bridge circuit is the same. The low-resistance pickup adjustment rheostat is made with wire of higher temperature coefficient than the fixed resistor and the calibration rheostat *A*. Changes in the value of the pickup adjustment rheostat are balanced against changes in other components by placing it in series with the RTD. While this circuit theoretically reduces the linearity of pickup adjustment, the magnitude of the effect is negligible.

The temperature rise of components within the relay has been found by test to be within American Standard Association standards. Under conditions existing before the relay has closed the overtemperature contacts, the internal temperature of the relay rises only 10 C to 12 C.

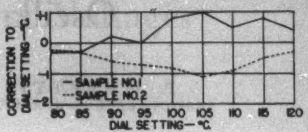

Fig. 4. Calibration curve of pickup adjustment

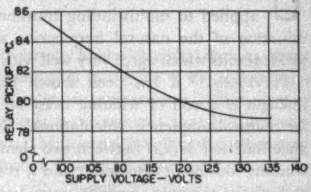

Fig. 5. Curve showing effect of supply voltage variation on relay operating point

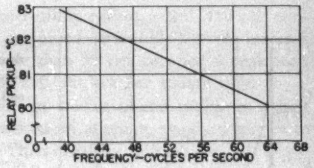

Fig. 6. Curve showing effect of supply frequency variation on relay operating point

After pickup, the auxiliary circuits dissipate considerable power which results in an additional 15-C rise.

The differential between overtemperature pickup and low-temperature contact closing over the range of pickup adjustment has been found by test to be within 0.5 C of being constant. This test establishes that relay torque is essentially unaffected by the presence of the pickup adjustment resistance in series with the RTD.

The effective contact-closing force per unit unbalance in the bridge circuit is more than adequate to establish current flow in the controlled circuits. This is based upon relative measurements of contact force with relays of proved reliability.

CONCLUSIONS

THE USE of the wattmetric unit as a measuring device of high sensitivity has advantages in compactness, reduced susceptibility to shock, and simplified design. The induced-voltage method of bridge excitation has provided several important improvements in design without any sacrifice in performance. It has been possible to provide compensation within the relay which maintains an over-all accuracy of measurement of 2 per cent of the overtemperature setting. The final result in terms of protective service is accuracy combined with reliability.

REFERENCES

1. Turbine Generator Stator-Winding Temperatures at Various Hydrogen Pressures, **J. R. M. Alger, C. E. Kilbourne, D. S. Snell.** AIEE *Power Apparatus and Systems*, April 1955, pp. 232–51.

2. Temperature Drop to Resistance Temperature Detector in Stator Windings of Turbine Generators, **R. P. Jerrard.** AIEE *Transactions*, vol. 73, pt. III-A, 1954, pp. 665–70.

3. Controls for Operation of Steam Turbine-Generator Units, **O. N. Bryant, C. C. Sterrett, D. M. Sauter.** AIEE *Transactions*, vol. 73, pt. III-A, 1954, pp. 79–88.

Oscillations of Coupled Windings

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USUALLY, SINGLE-WINDING THEORY has been applied to multiwinding transformers for the determination of the natural frequencies and, in some cases, yields results which agree very well with observation.

Previously,[1,2] it has been shown that all mutual flux linkages of a coil or winding must be taken into account for natural-frequency calculations. The mutual-inductance function $M(x,s)$ between two elements of the primary winding located at distances x and s, respectively, from one end of the winding depends upon both x and s when a secondary winding is present and short-circuited, since the flux pattern is changed. Fig. 1 shows the mutual-inductance function at the center ($x = 50$ per cent) of coil.

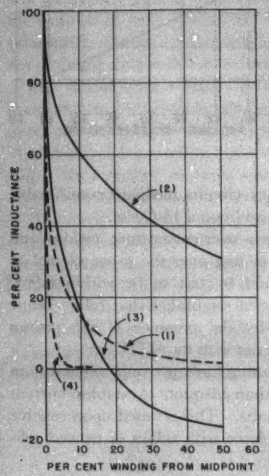
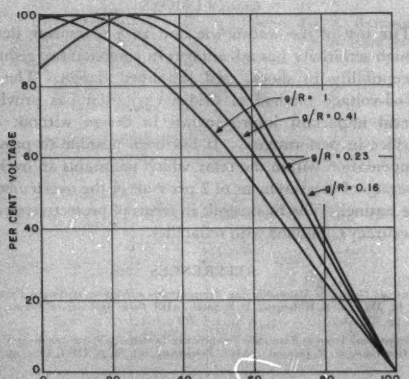


Fig. 1 (left). Mutual Inductance functions at center of an experimental coil.

1—Air Core, no secondary; 2—Iron core, no secondary; 3—Iron-core short-circuited secondary; 4—Air or iron-core copper screen

Fig. 2 (below). Fundamental voltage distributions of primary winding with isolated neutral for large values of g/R (gap/average radius), short-circuited secondary



By making use of the mutual inductance function as modified by the effect of the secondary, the integral-equation method[2] was extended to take into account the effect of the secondary upon the fundamental oscillation of the transformer. Fig. 2 shows the fundamental voltage distribution for a transformer with concentric windings having the primary line end grounded, primary neutral open, and secondary short-circuited and grounded.

Since the integral equation method is limited to the fundamental oscillation and to turn ratios of primary to secondary greater than about 5 to 1, the equivalent circuit method was used to determine the higher harmonics, the effect of turn ratios close to unity, and the effect of relative winding direction of primary and secondary.

In conclusion, it has been found by application of the integral-equation and equivalent-circuit methods that: (1) when the turn ratio is considerably different from unity, short-circuiting the secondary affects the frequencies with primary neutral isolated, but not the frequencies with primary neutral grounded; (2) in power transformers, the ratio of the first natural frequencies with grounded and isolated neutral usually varies between 5 and 12, if the secondary is absent or open-circuited, and between 1.1 and 1.6 depending upon the gap between primary and secondary, if the secondary is short-circuited; (3) the values of the frequencies of two coupled windings with primary neutral isolated decrease gradually as the secondary terminal conditions change as follows: both terminals isolated, short-circuited and isolated, both grounded, one grounded and one isolated; (4) when the turn ratio approaches unity, the effect of the secondary is more pronounced when the two windings are wound in opposite directions than when they are wound in the same direction; and (5) the computation of impulse voltages in a power transformer may be done with a good approximation considering only the impulsed winding, provided the neutral of the impulsed winding is grounded and the turn ratio differs considerably from unity; if the neutral of the impulsed winding is isolated, or if the turn ratio is close to unity, both windings must be considered.

REFERENCES

1. Natural Frequencies of Coils and Windings Determined by Equivalent Circuit, **P. A. Abetti, F. J. Maginniss.** AIEE *Transactions*, vol. 72, pt. 3, 1953, pp. 495–504.

2. Fundamental Oscillations of Coils and Windings, **P. A. Abetti, F. J. Maginniss.** *Ibid.*, vol. 73, pt. 3-A, 1954, pp. 1–10.

Digest of paper 55-29, "Oscillations of Coupled Windings," recommended by the AIEE Committee on Transformers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in the AIEE *Power Apparatus and Systems*, April 1955, pp. 12–21.

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Economics of Various Secondary Voltages

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THE GENERAL USE OF HIGHER VOLTAGES for distribution of power in commercial areas has many facets, one of the most important being economics. This digest deals with the economic comparison of power distribution in congested commercial areas at 120/208 volts and 265/460 volts. These voltages are the nominal system voltages. The specific areas considered are in the borough of Manhattan, New York, N. Y., but are similar to those generally encountered in any large metropolitan area. Underground distribution systems only were studied.

The economic comparison is based on installed cost of network transformers, network protectors, vaults, secondary mains and secondary ducts, and primary laterals; no cost for main primary feeders, secondary service, secondary manholes, or metering is included. It is assumed that all utility consumers are served at secondary voltage. Primary-feeder outage is based on second contingency; that is, the system must operate under emergency conditions of two primary feeders out at one time.

Unit costs were established for the installed equipments and all results of these studies show costs of a 265/460-volt system in per unit of 120/208-volt system costs. The comparisons are thus quite general and for areas other than those studied, per unit dollars can be used accordingly.

Uniform peak load densities of 10,000 to 200,000 kva per square mile were studied for a conventional secondary network at 120/208 volts and at 265/460 volts. For each of these cases, all the load is served at the secondary voltage under consideration. An "optimizing" procedure was used in which the "right-sized" transformer, and network protectors and cables are utilized even if they are actually nonexistent. The optimizing procedure makes it possible to obtain costs of the two systems on the basis of utilizing maximum capability of equipment, and thus it gives a fair economic comparison for the two system voltage.

Spot-networks, which consist of multitransformer installations supplying large concentrated loads, were studied to obtain an economic comparison of the two voltages.

The economics of spot-networks were also studied on the basis of interconnecting two spots and supplying additional load by means of multiple radial secondaries which supply load reasonably close to the spot-network. It is found there is a limiting distance beyond which two spot-networks cannot be economically interconnected.

When a spot-network is permitted to pick up more load by "reaching" out for nearby load with radial circuits, there is considerable economic gain in the use of the higher voltage. This system is called a spot-network/radial system.

To be realistic it must be recognized that 120/208-volt loads must be served. Multiple 460-volt radial secondary circuits emanating from a 460-volt spot-network can supply power to an isolated 120/208-volt grid through autotransformers. The conclusions of case studies are:

1. For an idealized utility system, a 265/460-volt conventional network compared to a 120/208-volt network shows savings of more than 35 per cent for a peak load density of 10,000 to 240,000 kva per square mile.

2. There is sufficient saving to the utility to adopt 460-volt spot-networks as an alternate standard service to 208 volts for certain types of load.

3. Multibank installations for supplying concentrated loads may be made at 265/460 volts for about 25 per cent less than at 120/208 volts when the demand is 4,000 kva or more.

4. Load in blocks of less than 2,000 kva near an existing 460-volt spot-network which is not loaded to full capability may be supplied economically by reaching out from the spot-network with radial secondary mains. Reach load can be supplied economically at 460 volts but not at 208 volts. A single concentrated load plus reach load results in spot-networks large enough to realize savings not obtained by supplying only a single spot load. Such a spot-network with its associated radial secondary mains is termed a spot-network/radial system.

5. Similar blocks of 120/208-volt load may be picked up by 460- to 208-volt wye-connected autotransformers supplied by the radial mains in the spot-network/radial system. In this case, the economies are reduced by the cost of the autotransformers. In a new area a spot-network/radial system with autotransformation can supply load all at 208 volts, at substantially the same cost as a conventional 208-volt network. Where some load can be served at 460 volts, savings will be realized.

6. The 460-volt spot-network/radial system is more economical than the general 460-volt network for load densities approximately 60,000 kva and up.

7. A 460-volt spot-network may be installed economically even if the initial load is only 1,000 kva, provided the annual load increase within about 500 feet of the spot is more than 150 kva per year.

8. Additional capacity, up to about the rating of one transformer, can be made available to a small spot-network more economically by interconnecting with another nearby spot than by installing an additional transformer.

Digest of one of the eleven papers in special publication S-66, recommended by the AIEE Transmission and Distribution and Industrial Systems Committees and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 11-15, 1954.

T. C. Duncan, J. P. Neubauer, and J. M. Comly are with Consolidated Edison Company, New York, N. Y.; R. F. Lawrence and Miles Maxwell are with Westinghouse Electric Corporation, East Pittsburgh, Pa.

Emergency Electric Systems for Jet Aircraft

MERLE SMALLBERG

In view of the possibilities of various types of primary power system failure in jet aircraft, provision for emergency electric power is essential. Several feasible systems for emergency power generation in jet fighter, cargo, and bomber aircraft, as well as the important design considerations, are presented.

"POP-OUT" emergency ram-air turbine power packages are becoming increasingly popular throughout the piloted aircraft field. These power packages have been designed to withstand shock loads encountered by sudden ejection into air streams at speeds as high as Mach 1.3. A principal advantage of the pop-out installation is in the elimination of drag caused by duct losses experienced with internally mounted ram-air turbines. Furthermore, considerable space is saved by eliminating the entire duct system. A pop-out package, mounted on a fuselage door which swings out into air stream when the primary electric power source fails, is shown in Fig. 1.

RAM-AIR EMERGENCY POWER FOR JET FIGHTER AIRCRAFT

THE MOST PROBABLE fighter aircraft failure requiring emergency generation of electric power is an engine flame-out. A secondary possibility is the failure of the alternator drive and/or the main alternator itself.

Jet fighter aircraft have minimum approach and landing speeds high enough so that dynamic pressure is appreciable down to the time of touchdown. Thus, actuation of the ram-air turbine-driven emergency power unit can begin anywhere in the altitude–speed envelope, and the unit can deliver power throughout the power-off glide to touchdown.

Fig. 1. Pop-out type ram-air emergency power unit

A family of simple single-stage axial turbines has been developed so that, within moderate over-all size and weight limitations, appreciable emergency electric power can be delivered. Power generated by a typical 12-inch diameter turbine is shown in Fig. 2. The rotor consists of a number of aerodynamic foils designed to operate over a wide speed range without stalling. The rotor is directly connected to the alternator and pump shaft and operates at nominal speeds of from 6 to 9,000 rpm. The shroud around the rotor serves to direct all air flow through the governor, and provides structural support for the governor assembly. The speed control consists of a fly ball governor which actuates rotating blocking vanes located downstream of the rotor. Rotation of the blocking vanes varies the power output. Steady-state speed regulation of ± 1 per cent is achieved.

Various types of alternators can be used with this family of units. The model illustrated in Fig. 3 delivers 1.2 kva, 120/208 volts, 3-phase, 400 cycles at 1.0 power factor. Another model provides 2.5 kva, 120/208 volts, 3-phase, 400 cycles, at 0.85 power factor. This particular machine also contains a 10-ampere, 28-volt d-c generator in the same housing. The generator and alternator are of conventional construction, a portion of the d-c generator output providing excitation for the alternator. The d-c generator is capable of self-starting by virtue of residual magnetism. A third alternator under development for this family of units has a nominal rating of 3.2 kva, 120/208 volts, 3-phase, 400 cycles at 0.75 power factor. It is of conventional design, but has an overload rating of 10 kva at 0.5 power factor for 50 milliseconds.

Except for special permanent-magnet emergency alternators, magnetic-amplifier voltage regulators are usually used. In early applications, a separate regulator box, remotely located from the pop-out unit, was used. It is more desirable to mount the regulator assembly with the alternator to take advantage of air cooling, easier assembly, and reduction in the vulnerable exposure area.

The size and weight premium on the pop-out assembly makes boot-strap excitation of the alternator very desirable. The alternator should be self-starting to eliminate dependence upon another d-c emergency bus. Some aircraft installations require a small amount of d-c emergency power. It is considered desirable to provide this power from transformer-rectifiers mounted with the regulator,

Revised text of a District paper presented at the AIEE Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955, and recommended for publication by the AIEE Committee on Air Transportation.

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although an alternator-generator assembly can be used as described.

Even with the potential of ram-air cooling at the pop-out fuselage door location, it is considered desirable to design all components of the system for high environmental temperature resistance. Thus, silicones and epoxy resins are used in the alternator, and it will be desirable to use silicon diodes in the regulator and transformer-rectifier.

Operation of hydraulic components such as flight surface controls and landing gear are essential in effecting emergency return and landing. Therefore, the ram-air turbine also drives a hydraulic pump which is directly connected to the alternator shaft. It has been proposed, as an alternate to the system described, to have the ram-air turbine drive a larger hydraulic pump. Then, a hydraulic motor would drive the alternator, the latter assembly being located within the fuselage. This system would be somewhat more complex, have a larger vulnerable exposure area, and have greater total weight but could lead to lighter pop-out weights. The weight of individual members of this family of machines varies with the rotor size, type of alternator, and size of the hydraulic pump required.

The time required for the ram-air unit to take over its emergency duties is dependent upon the time required to extend the unit into the air stream, and the time for the turbine to accelerate under load. Typically, the unit may be extended into the air stream within 1 second. The time to reach stabilized speed varies from approximately 2 seconds at the lowest speeds and highest loads to under half a second at 500 knots pop-out speed. The characteristic time constant of the unit and governor is about 0.2 seconds. Emergency power units of this family may be safely extended at any speed up to 800 knots.

EMERGENCY POWER FOR JET CARGO AND BOMBER AIRCRAFT

EMERGENCY POWER generation may be required in this category of aircraft in case of one or more engine failures or the failure of one or more shaft or bleed-air driven main alternators. Because of the very remote possibility of failure of all engines normally powering the main alternators, there is a high probability that alternate engine-powered drives can be used for emergency power generation. Use of a duct-mounted emergency ram-air turbine unit is a possibility, although the lower approach and landing speeds of the larger aircraft mean that power would be available only for a minimum of lighting, controls, and flight instrument loads. A pop-out ram-air unit is also a possibility for this type of aircraft.

Auxiliary gas-turbine power units are installed in some large aircraft to supply electric power on the ground. It would be feasible to make use of these units for in-flight emergencies. However, current small gas-turbine units are very limited in power output at high altitude, and it is a premise in the selection of an emergency system that it must be capable of use at any operating altitude.

Most large jet aircraft have at least a minimum of batteries for fire detection and extinguisher actuation, and for emergency lighting. The battery installation could be increased to provide sufficient power for taking over peak

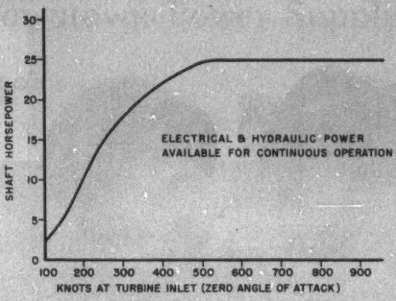

Fig. 2. Horsepower–speed characteristic of ram-air turbine-driven emergency power unit

loads, and thus supplement other emergency systems. If batteries alone were relied upon for emergency operation for the long flight home, the weight penalty and storage problems involved would be intolerable. On the premise that one or more engines remain in operation, a small bleed-air turbine-driven alternator (Fig. 4) may be used as an emergency power source. This type of drive is more flexible than the shaft-driven alternator, since the bleed-air inlet may be switched from an inoperative engine to a good one. This type of unit can operate normally as an isolated power source, and take over a larger load in an emergency.

A comparative analysis based upon size, weight, performance at altitude, over-all efficiency, and reliability (because of power source duplication) show advantages in the use of the bleed-air turbine unit as a combination isolated power and emergency source. As an example of what can be achieved by incorporating latest developments in turbine, alternator, regulator, and installation technology, the following characteristics of the unit illustrated are given:

1. *Turbine.* For simplicity, small size, and light weight (although sacrificing some performance), a single-stage, radial inflow turbine operating at 24,000 rpm is selected. A variable inlet area throttle can give high efficiency at low power level when operating as an isolated power source and when operating at the highest emergency overload.

2. *Alternator.* A two-pole alternator, 400 cycles, 120/208 volts, 3-phase, operating at the 24,000 shaft turbine speed is selected on the basis of smallest size and lowest weight. Either a permanent-magnet or conventional construction alternator is feasible. As one example of the possible rating for this class machine, 1 kva could be provided as a continuously operated isolated source for one set of flight instruments. Ten kva could be supplied during continuous emergency operation and 30 kva (at lower power factor) could be delivered for very short time overloads. Permanent-magnet inserts can be placed in the rotor of the conventional machine so that it may be started without outside d-c excitation. The alternator would be air-blast cooled, and bootstrap excitation would be used.

3. *Regulator.* A magnetic-amplifier regulator would be used with the conventional alternator. The permanent-magnet generator could be constructed with an internal

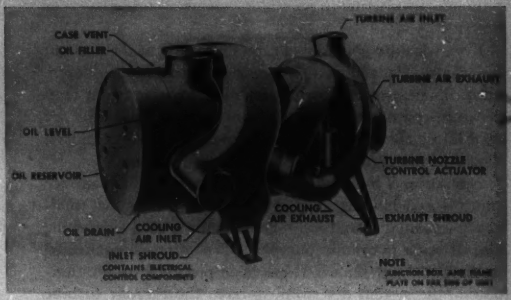

Fig. 3 (left). Alternator for use with single-stage axial turbines. Fig. 4 (right). Bleed-air turbine-driven alternator

regulator device. For high ambient temperature operation, silicon diodes would be used in the regulator for a voltage reference source as well as for rectifiers. Air-blast cooling would be employed.

4. *Frequency Control.* A hydraulic proportional-plus-integral governor would be used. The governor fly balls are driven at a speed lower than the turbine-shaft speed. Hydraulic pumps, mounted with the governor, would provide forced lubrication and scavenging of the bearings. By extension of this hydraulic system, use of an oil-cooled alternator would be feasible.

5. *Installation.* It is desirable to mount this type of assembly adjacent to an engine, preferably in a nacelle. The shorter air ducts and decreased exposed vulnerable area offer advantages. Intake of ram-air for blast cooling is made easier. More important, ducting of the turbine exhaust into the engine tailpipe ejector would be permitted, thus increasing turbine efficiency.

SPECIAL DESIGN CONSIDERATIONS

THE VOLTAGE and frequency steady-state values and regulation accuracy of the emergency alternators approximate those for the main alternators. Any decrease in regulation requirements, by special attention to the design of the emergency loads, would further decrease the cost and complexity of the emergency power source. Since the steady-state load values may vary widely if the emergency system is used also as an isolated power source, a premium is placed upon an alternator drive device providing high efficiency over a wide range of operation.

The design of the alternator must be adequate for emergency situations where a load, such as a flap motor, must be started just as the emergency generator is coming up to speed. Transient loads caused by the motor starting at any operating condition leads to the requirement for much higher than normal overload rating of the alternator. For instance, up to 300-per-cent overload rating in contrast to the usual 200-per-cent rating is desirable. Voltage must be maintained close to normal at very low power factors and at decreased shaft speeds. These critical starting requirements mean that the locked-rotor torque of the motor load, over a varying temperature range, and the motor's locked-rotor power factor become important design criteria for the alternator. With the exception of short-time motor starting loads, the emergency load remains fairly constant. It is desirable, however, to hold maximum speed excursion during 100-per-cent load changes to within ±5 per cent.

ESSENTIAL EMERGENCY ELECTRIC LOADS

THE LOADS considered for emergency actuation are generally the minimum required for sustaining flight to the nearest friendly base and effecting a safe landing. Those loads which are considered to be the minimum vary according to the user, but probably include the following:

1. *Fighter (engine off).* Flight instruments (including Pitot tube heat); radio; landing-flap, and trim motors; hydraulic selector valves; minimum lighting; detectors and emergency actuators (fire extinguisher, firewall shutoff valves, landing gear position, ice accretion); auxiliary fuel tank and armament jettison actuators; and fuel boost pump for engine restarting.

2. *Jet Cargo and Bomber (some engines operating).* The minimum emergency loads would consist of those listed for fighters plus: engine instruments; controls and turboprop propeller controls; heating, ventilating, and pressurization controls; fuel boost and transfer pumps; interphone; bail-out alarm; and auxiliary gas-turbine starter and controls.

ACTUATION

ACTUATION of the emergency power system may be performed by a combination of manual and automatic means. Sufficient time must be given for fault-clearing in the main circuit, if possible. In fighter aircraft, an engine flameout is spectacular enough to attract attention to the necessity for operating one manual lever. Then the pop-out unit will be extended, followed by automatic switching to remove the nonemergency loads from the bus, giving relief to the pilot. In the larger aircraft, it also is desirable to have one manual lever for actuating the emergency power system, followed by automatic start of the emergency system and automatic switching to the emergency load.

Load pickups within 5 seconds appear achievable with all systems discussed. The pickup speed advantage goes to the emergency power generating system already operating in another capacity prior to the emergency.

Switchgear for Pittsburgh's Downtown Power Supply

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IN THE PLANNING of the Pittsburgh downtown 69-kv power supply, several factors had to be considered in the design of switchgear equipment: The substation area was limited, the high-voltage circuits were subject to lightning exposure, appearance requirements were dictated by a downtown area development, and safety was important.

Conventional indoor station-type cubicle construction with compressed-air circuit breakers were applied on the 12-kv primary distribution circuits, as shown in Fig. 1.

The 69-kv switchgear presented three major problems: (1) a combination of bus and enclosure size which would withstand 350-kv impulse; (2) a supporting insulator which would withstand 350-kv impulse; and (3) a disconnecting switch which would meet the impulse and space limitations.

Several diameters of furnace pipe enclosures and 3-, 4-, and 6-inch-diameter conductor were tested in the impulse laboratory. From these tests the most economical sizes proved to be a 4-inch-outside-diameter round conductor in a 38-inch-inside-diameter enclosure.

Tests determined that a new approach to the porcelain bus-support end adjacent the conductor had to be developed. Conventional insulators, with or without hardware, developed high-stress conditions at the point of contact with the bus which triggered a flashover. Correction of this condition seemed possible if this stress condition could be moved down into the body of the insulator, where it would be opposed by porcelain puncture strength instead of surface creepage.

Many combinations of parts were tested, and it was found that the depth of penetration of the hardware insert into the insulator body, the contour of the insert, the material used to secure the insert into the insulator, the projection of the insert above the top of the insulator, and the thickness and quality of the porcelain wall, were all critical factors requiring co-ordination before satisfactory results were obtained. A satisfactory combination of factors was accomplished and throughout the remaining test program no insulator flashovers were encountered.

The tests on busses determined that a disconnect switch presenting bus contours in the closed position would withstand the impulse level in that position. Also, if a section of the bus representing a blade were telescoped into fixed sections of the bus, minimum clearances and enclosure sizes would result. The switch design was, therefore, based on telescoping the switch blade either into a section of bus or into the hollow conductor of a capacitor bushing. The blade was moved longitudinally by a supporting insulator mounted on a guided platform driven by a rack-and-pinion mechanism. Contact between the blade and stationary bus parts was completed by flexible silverplated-finger assemblies.

Fig. 1 (left). Typical station-type cubicle: compressed-air circuit breaker in compartment at left; main bus at top right; isolating switch below; line compartment and switch lower right with provision for line connections to line terminating equipment below. Phases segregated by grounded metal barriers. Fig. 2 (right). Telescoping-type disconnecting-switch pole unit with inspection door open and switch in open position; section of 69-kv bus with inspection cover removed above. Finger contact assemblies are enclosed in static shields at insulator locations

The switch design met its requirements in the closed position, but an elaborate corona shield had to be developed to shield the blade tip when in the open position (Fig. 2).

Design test values were obtained in which impulse values are corrected for weather and taken from oscillograms:

Impulse withstand, positive wave	350 kv
Impulse withstand, negative wave	above 425-kv limit of generator
60-cycle 1-minute withstand voltage	160 kv
Bus-support insulator, dry flashover	210 kv
Bus-support insulator, dew flashover	160 kv
Radio influence level	25 mv

The test data, comprising approximately 2,000 impulse tests, accumulated during tests determined contours and clearances, permitting design of the incoming line and potential transformer enclosures. These parts were then associated together with the 69-kv compressed-air circuit breakers, as required by the circuitry of the single-line diagram for the substation.

Digest of paper 55-214, "Pittsburgh Downtown 69-Kv Power Supply; Part III—Switchgear Development," recommended by the AIEE Committee on Switchgear and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31-February 4, 1955. Published in AIEE *Power Apparatus and Systems*, August 1955, pp. 653–7.

P. R. Pierson is with Westinghouse Electric Coporation, East Pittsburgh, Pa.

Contributors to the accomplishment of insulator design are B. P. Baker, J. F. Peters, E. Beck, and G. Gilchrist.

REFERENCE

1. A New 69-Kv Compressed-Air Circuit Breaker, B. P. Baker, E. Frisch. AIEE *Transactions*, vol. 68, pt. I, 1949, pp. 363–72.

Magnetic Amplifiers in Bistable Operation

L. A. FINZI MEMBER AIEE
G. C. FETH STUDENT MEMBER AIEE

BISTABLE MAGNETIC AMPLIFIERS are characterized by two widely different stable levels of output, one close to quiescent and the other close to fully saturated conditions. This "flip-flop" operation is desirable in some applications and can be achieved intentionally by over-regenerative mmf of one sort or another, properly introduced to modify the characteristic of self-saturating amplifiers.

Predictions of bistable amplifier behavior are obtained reliably by simple procedures, if one takes as starting point the transfer characteristic of the self-saturating amplifier, either calculated carefully under consideration of core and rectifier properties or, even better, measured experimentally. Overly simplified approaches, on the other hand, are not meaningful.

The mechanism of transition from the one output level to the other deserves detailed consideration in view of the well-known sluggishness of the response of these bistable amplifiers. Methods that are familiar in the study of the transient response of common amplifiers with low-suppression index to even harmonics are extended to this situation. The differential equation of the control circuit is written under recognition that its flux linkages are related linearly to the output voltage; integration is performed by procedures that are also familiar.

It is recognized that the *S*-shaped steady-state transfer characteristic represents the locus of points that are actually transversed in the transition as evidenced by Fig. 1, in which the half-cyclic voltage V_L is related to the half-cyclic mmf of control N_cI_c. (Averaging networks at the oscilloscope terminals have been used to reduce blurring of the trace.) Attention must be given to the meaning of the slopes of the various portions of this characteristic, relevant for the differential equation at hand.

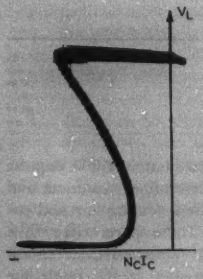


Fig. 1. Locus of points V_L, N_cI_c described in a switching process

The differential equation is rewritten so as to express the rate of change in terms of the "actuating" part of the signal voltage (that is, in terms of the difference between the control voltage applied and the half-cyclic average of resistive drop at the instant considered). Thus information concerning the speed at which the transition is taking place at various points for given control voltages is obtained by inspection of the steady-state transfer characteristic. Practically, a large portion of the total transition time is spent passing around the first "corner" met in the switching process. This is particularly important in amplifiers with a prescribed narrow band of instability.

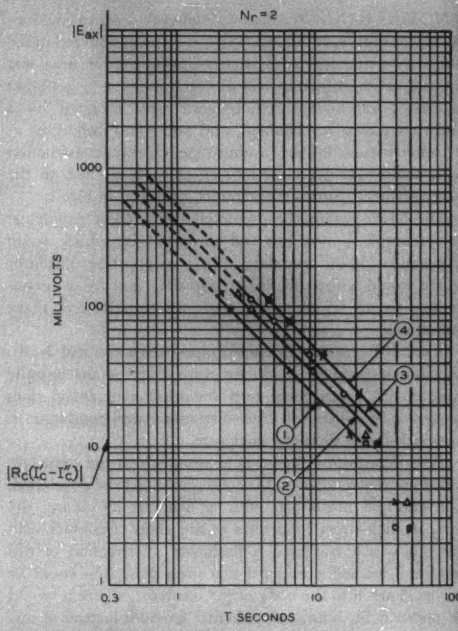


Fig. 2. Experimental investigation of the influence of $|E_{ax}|$ upon response; over-regenerative current feedback.

Curve 1—Time to 63.2 per cent of total swing; build-down process; Curve 2—Time to 86.5 per cent of total swing; build-down process; Curve 3—Time to 63.2 per cent of total swing, build-up process; Curve 4—Time to 86.5 per cent of total swing, build-up process

Experimental results shown in Fig. 2 for a bistable center-tap amplifier indicate that times to 63.2 and 86.5 per cent of total swing are almost inversely proportional to the minimum actuating voltage E_{ax} at the first corner met in the build-up or build-down process. Short-cuts based on "apparent control circuit inductance," i.e., linearization of the transfer characteristic in the shape of an inverted *Z*, are not appropriate because they radically modify those parts of the transfer characteristic which are of prime importance in terms of transient response.

Digest of paper 55-539, "Magnetic Amplifiers in Bistable Operation," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operation for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Scheduled for publication in AIEE *Communication and Electronics*, 1955.

L. A. Finzi and G. C. Feth are with Carnegie Institute of Technology, Pittsburgh, Pa.

This work has been supported in part by the U. S. Office of Naval Research.

Analytical Method for Design of Relay Servos

J. E. HART
ASSOCIATE MEMBER AIEE

RELAY SERVOMECHANISMS, in general, show advantages over continuous servomechanisms with regard to cost, size, weight, and complexity. The application of relay servomechanisms, however, has been retarded by the meager understanding of obtainable operating characteristics and the lack of practical design methods.

The design method described in this digest is based on analytical expressions of deadbeat criteria, wherein the system parameters are involved in nondimensional form. For a deadbeat response, the relaying device will close and open only once when the system is subjected to an input.

For a simple second-order system a phase plane, with the boundary equations and the trajectory equation[1] for the region where the relay is open, is shown in Fig 1. The relay pull-in voltage is indicated nondimensionally by ϵ, and the ratio of drop-out to pull-in voltage by λ. Substituting the initial and final values of position and velocity into the trajectory equation gives the deadbeat criterion for the case where the initial velocity has its maximum value, namely unity. Thus, $0+\epsilon>1-\lambda\epsilon$ or $\epsilon>1/1+\lambda$.

If the system is deadbeat for the case where the initial velocity is maximum, it is deadbeat for any smaller initial velocity.

In a practical system, it is frequently desirable to employ velocity feedback, represented nondimensionally by κ, or velocity-squared feedback β to improve the response.[2,3] Additional parameters, which generally must be considered, include the amount of dynamic braking employed α, the braking torque ϕ of a friction brake applied when the relay is open, the operating time of the relay τ, and the coulomb friction Δ.

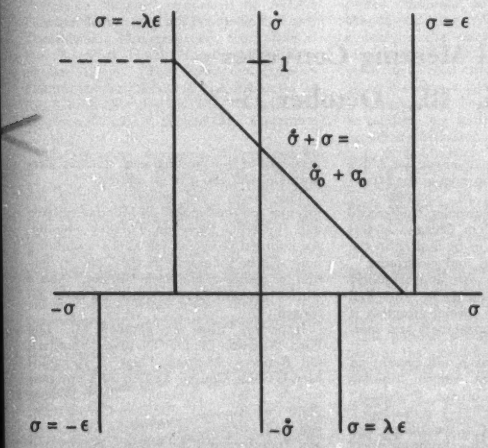


Fig. 1. Deadbeat response and trajectory equation

The deadbeat criteria for systems, wherein these parameters are considered, are determined in a manner similar to that employed for the simple case and give the following expressions:

$$\epsilon > \frac{\left(\tau+\frac{1}{\alpha}-\kappa\right)(1-\Delta\phi)-\frac{\phi}{\alpha^2}\ln 1+\frac{\alpha(1-\Delta\phi)}{\phi}}{1+\lambda}$$

and

$$\epsilon > \frac{\tau+\frac{1}{\alpha}-\beta(1-\Delta\phi)(1-\Delta\phi)-\frac{\phi}{\alpha^2}\ln 1+\frac{\alpha(1-\Delta\phi)}{\phi}}{1+\lambda}$$

The numerator of the right-hand side of these inequalities may be considered as a design variable x and related graphically to the parameters α, β, κ, ϕ, Δ, and τ.

Design Procedure. For relay servomechanisms, it is desirable that the specifications state the allowable static and steady-state following errors, the allowable overshoot, and the maximum allowable transient times. Specifications of bandwidth or other frequency characteristics would require a complex interpretation because of the nonsinusoidal form of the output of a relay servomechanism when subjected to a sinusoidal forcing function and, also, because of the effect of input magnitude on the output wave shape.

The design of a relay servomechanism is carried out by first calculating the motor power required from considerations of the maximum motor speed, the load characteristics, and the approximate accelerations required. The sensitivity required for the error source and relay pull-in voltage may be calculated to give the specified value of dead zone. From these data the value of ϵ may be calculated. With the selection of a relay, or pilot and power relays, the value of λ is obtained. Assuming the system to be deadbeat, the required value of x is obtained from the inequality $x < \epsilon/(1+\lambda)$. The value of τ is determined for the relay assumed and this parameter, together with the required value of x, permits determination of various sets of the remaining parameters. This information and knowledge of the relay pull-in time will indicate alternate arrangements which may be utilized to meet the required specifications. Testing of a mockup will be necessary for adjustment, and to indicate allowable values of backlash and resolution requirements.

REFERENCES

1. Analysis of Relay Servomechanisms, **H. K. Weiss.** *Journal of Aeronautical Sciences*, New York, N. Y., vol. 13, no. 7, July 1946, pp. 364–76.

2. Automatic and Manual Control (book), **A. M. Uttley, P. H. Hammond.** Butterworth's Scientific Publications, London, England, 1952, pp. 285–99.

3. The Simplest Relay System of Automatic Regulation, **A. A. Feldbaum.** Avtomatika i Telemechanika, Moscow, Russia, vol. 10, no. 4, 1949, pp. 249–66.

Digest of paper 55-187, "An Analytical Method for the Design of Relay Servomechanisms," recommended by the AIEE Committee on Feedback Control Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Applications and Industry*, May 1955, pp. 83–90.

J. E. Hart is with the Naval Research Laboratory, Washington, D. C.

INSTITUTE ACTIVITIES

380 Technical Papers Anticipated for AIEE's 1956 Winter General Meeting

APPROXIMATELY 380 PAPERS and 95 technical sessions are anticipated for the 1956 AIEE Winter General Meeting. Also, there are advance indications that more than 5,000 members and guests will register for next year's meeting, to be held January 30–February 3 at the Hotels Statler and Governor Clinton, New York, N. Y.

Technical Sessions

As this issue goes to press it is impossible to give a definite report on the committees sponsoring technical sessions. However, it may be assumed that most of the 43 committees in the five technical divisions will be represented. More information will be in the December issue of *Electrical Engineering*.

Hotel Reservations

Blocks of rooms have been set aside at the Statler and nearby hotels for members and guests attending the meeting. Requests for reservations should be sent to the hotel of your choice, and to only one hotel, with a specific reference to the AIEE meeting. If the request cannot be filled, the hotel will automatically refer the request to the Hotel Accommodations Committee. The committee then will obtain a suitable reservation at another of the convention hotels. Reservations should be sent before January 16, 1956.

Because of crowded conditions in New York hotels, it is suggested that reservation be made for arrival on Sunday, January 29, 1956. This will prevent delays in registration or unavailability of rooms in the early morning of subsequent days. It is also suggested that a request for reservation prior to Christmas is much more likely to be filled at the hotels of members' first choice.

Details concerning hotels and rates will appear in the December issue of *Electrical Engineering*.

Theater Tickets

Theater tickets will be provided for members who want to see stage shows. However, the committee under the chairmanship of S. Friend, Jr., feels it is inadvisable at this time to give a specific listing of shows that will be playing during the meeting. A complete listing of shows also is scheduled for the December issue, and it is requested that all inquiries be deferred until that time.

Tickets to available radio broadcasts and television shows will be provided at the time of registration.

Smoker Committee

A highlight of the Winter Meeting will be the Smoker to be held Tuesday evening, January 31, 1956. Good food, good fellowship, and top quality entertainment will be the feature of this event which will take place in the Hotel Statler.

Attendance will be limited for the comfort of guests and ticket requests should be mailed at an early date. These requests should be addressed to D. Halloran, Room 1250S, 4 Irving Place, New York 3, N. Y., and should be accompanied by checks made payable to the "AIEE Smoker Committee." The ticket price will be $10.00 per person.

Dinner-Dance

A Dinner-Dance will be held Thursday evening, February 2, in the Grand Ballroom of the Hotel Statler. General arrangements will be the same as those which proved enjoyable last year. Dress will be formal. Write soon for reservations at tables for ten. Address requests to: E. J. Doyle, American Telephone and Telegraph Co., 195 Broadway, New York 7, N. Y. When sending remittances, make checks payable to the "AIEE Dinner-Dance Committee."

Inspection Trips

An interesting program of inspection trips is being prepared. In addition to new trips, some of the more popular trips of past meetings may be rescheduled, such as Radio City Music Hall, Federal Pacific Electric Company, Fairless Plant of U. S. Steel Corporation, and Brookhaven National Laboratory.

Ladies Entertainment

The Ladies Entertainment Committee, under the chairmanship of Mrs. Merwin Brandon, is planning a varied program. On Monday, there will be a "Get Acquainted Tea." A dinner and luncheon, plus several tours also are scheduled.

Winter General Meeting Committee

Members of the 1955 Winter General Meeting Committee are: A. J. Cooper, chairman; D. M. Quick, vice-chairman; J. J. Anderson, secretary; J. P. Neubauer, budget co-ordinator and AIEE Vice-President for District 3; J. D. Tebo, chairman, Committee on Technical Operations, F. S. Black, public relations; R. T. Weil, general session; Avery Gould, dinner-dance; D. V. Buchanan, hotel accommodations; J. V. O'Connor, inspection trips; Morris Brenner, registration; R. W. Gillette, smoker; R. R. Meola, monitors; S. Friend, Jr., theater and broadcast tickets; Mrs. Merwin Brandon, ladies' committee; C. T. Hatcher, ex officio member (past chairman).

Informal Tea

This social gathering before the formal program begins has been enjoyed by more and more people each year. Make it a point to attend this year—Sunday afternoon, January 29, from 4 to 6 p.m., in the Georgian Room of the Statler. There will be no charge.

During this period the registration facilities will be open for those wishing to avoid the Monday morning rush.

Fall General Meeting Convenes In Chicago, Ill., October 3–7

AS THIS ISSUE goes to press, the AIEE Fall General Meeting convenes at the Morrison Hotel in Chicago, Ill., October 3–7. With the National Electronics Conference (NEC) also being held in Chicago at this time, there is little left to be desired in the fields of communication and electronics.

Thirty-nine sessions with approximately 160 papers are scheduled for the Fall Meeting, and this year special attention is being given to rotating machinery and communication.

President M. D. Hooven will present an address to the General Session Monday afternoon ("Solidarity of the Profession" which appears on pages 953–4 of this issue). A. V. Kahler, president of the Illinois Bell Telephone Company, will welcome members at this session and J. A. Hutcheson, vice-president of the Westinghouse Electric Corporation, will also give an address.

The main social activities during the meeting are the Smoker on Monday evening and the NEC Party on Tuesday evening. An informal reception tea and a hospitality hour will be sponsored by the Chicago Section for members and their families. Also a varied program for the ladies has been arranged.

Inspection trips are planned to: The Ford Aircraft Engine Division, Standard Oil Refinery, McCook Plant of Reynolds Metals, Will County Station of Commonwealth Edison Company, Electromotive Plant of General Motors Corporation, Rauland Corporation, Museum of Science and Industry, and the recently constructed Prudential Building.

SHAKING HANDS at the Fall General Meeting held in Chicago, Ill., October 3–7, are (left to right): AIEE Secretary N. S. Hibshman; President M. D. Hooven; J. A. Hutcheson, vice-president of the Westinghouse Electric Corporation, who spoke at the General Session; and A. V. Kahler, president of the Illinois Bell Telephone Company, who gave a welcome address.

Among those who have helped are the following: General Chairman Francis A. Cox; Vice-Chairman William M. Ballenger; Secretary Howard R. Stevens; Treasurer Richard W. Jones; G. Leslie Welch, hotel arrangements; Frank M. Scott, finance and budget; Robert M. Bergslien, technical program; George E. Buchanan, registration; Donald M. Pearcy, trips-transportation; Merlin J. Adams, dinner-dance; Edward H. Finch, smoker; Foster A. Larson, entertainment; Michael J. O'Laughlin, sale of papers; Mrs. Robert B. Gear, ladies activities; Eldridge H. McNeill, hospitality; Edwin R. Whitehead, general session; Andrew W. Kramer, publicity.

Electrical Conference of Petroleum Industry Held in Texas; '56 Meeting to Be in Missouri

FOUR-HUNDRED AND TWENTY engineers from 22 states and Venezuela attended this year's Electrical Conference of the Petroleum Industry, sponsored by AIEE's Houston Section and the Petroleum Industry Committee. The conference took place at the Shamrock Hotel, Houston, Tex., September 12–14. (The Petroleum Industry Committee has accepted the invitation of the Kansas City Section (Mo.) to hold next year's conference in Kansas City, September 17–19.)

The Keynote Address was presented by F. M. Austin, vice-president, Houston Lighting and Power Company and a past chairman of the Houston Section. He said that the primary aim of the conference was the development of understanding, and the knowledge that understanding must precede wise action. He said, too, that electricity, oil, and gas are "merely sources of energy, which when wisely directed, will get things done," and that the engineer's job is "to devise and improve the means of their wise direction."

Mr. Austin thought that a sound comprehension of economic and technical facts is one of the greatest duties of engineers. ". . . A man who devotes all of his time to a single activity does not really acquire 'know-how' . . . An engineer is a man of myriad parts and, if he would really grow in stature, he must continually expand his knowledge along many lines."

Mayor Roy Hofheinz of Houston welcomed conferees at the General Session Monday morning. He said that he has been amazed at the electrical mechanization in pipelines. The important contribution to the nation's economy of oil resources located about Houston was also emphasized.

A highlight of the conference luncheon was an address by Lamar W. McLeod, vice-president, Westinghouse Electric Corporation, St. Louis, Mo. His subject was, "Outlook for Atomic Power." He said that when a speaker mentioned "atomic power" 20 years ago he was considered a "visionary." Ten years ago a speaker was referring to bombs. Then he said: "Today we can talk about atomic power as a God-given force which man has to harness to do useful work. This is a rather accurate barometer of the scientific progress that has been made in a very few years."

He pointed out that from 1 AD to the present the world has used about 11 to 14 energy units (one energy unit equals 10^{18} BTU) and that it is expected 5–10 energy units per year will be used by 2050 AD. He showed that estimated reserves of nuclear fuel are 1700 energy units and only 30–50 units of recoverable fossil fuels. He stressed that we have no alternative but to turn to

Future AIEE Meetings

Middle Atlantic Textile Conference
North Carolina State College, Raleigh, N. C.
November 3–4, 1955
(*Final date for submitting papers—closed*)

AIEE-IRE-ACM Eastern Computer Conference
Hotel Statler, Boston, Mass.
November 7–9, 1955
(*Final date for submitting papers—closed*)

Electrical Techniques in Medicine and Biology Conference
Shoreham Hotel, Washington, D. C.
November 14–16, 1955
(*Final date for submitting papers—closed*)

EJC-AIEE Nuclear Energy Conference
Cleveland, Ohio
December 12–17, 1955
(*Final date for submitting papers—closed*)

Winter General Meeting
Hotel Statler, New York, N. Y.
January 30–February 3, 1956
(*Final date for *TP—closed, †CP Syn.—Nov. 15 CP Ms—Nov. 30*)

AIEE-IRE-ACM Western Computer Conference
Fairmont Hotel, San Francisco, Calif.
February 8–10, 1956
(*Final date for submitting papers—Nov. 8*)

AIEE-IRE-University of Pennsylvania Transistor Circuit Conference
University of Pennsylvania
Philadelphia, Pa.
February 16–17, 1956
(*Final date for submitting papers—Nov. 16*)

Scintillation Counter Conference
Shoreham Hotel, Washington, D. C.
February 28–29, 1956
(*Final date for submitting papers—Nov. 28*)

Southern Textile Conference
Georgia Institute of Technology, Atlanta, Ga.
March 1–2, 1956
(*Final date for submitting papers—Dec. 1*)

Paper and Pulp Conference
University of Florida, Gainesville, Fla.
March 8–9, 1956
(*Final date for submitting papers—Dec. 8*)

AIEE, University of Illinois American Power Conference
Sherman Hotel, Chicago, Ill.
March 21–23, 1956
(*Final date for submitting papers—Dec. 21*)

South West District Meeting
Dallas, Tex.
April 2–4, 1956
(*Final date for TP—Jan. 3, ‡DP Syn.—Jan. 18 DPMs—Feb. 2*)

*TP—Transactions paper
†CP Syn.—Conference Synopsis, CP Ms—Conference Manuscript (The CP Syn. date is 15 days before the CP Ms date)
‡DP Syn.—District Synopsis DP Ms—District Manuscript (the DP Syn. date is 15 days before the DP Ms date)

THE ELECTRICAL CONFERENCE OF THE PETROLEUM INDUSTRY was held at the Shamrock Hotel in Houston, Tex., September 12–14. Left to right are: Dr. Carey Croneis, banquet speaker; J. Z. Unsenmeyer, chairman Petroleum Industry Committee; and H. M. Stewart, conference chairman.

atomic power to supplement the conventional fuels and that coal might become too valuable "a source of chemicals" to burn.

"Don't leap to the conclusion that King Coal or Queen Oil are about to abdicate their thrones next week. . . Atomic power will not replace but will supplement the conventional fuels for many years to come."

Mr. McLeod also estimated that by 1965 the nation will have 4,000,000 kw of installed electric power generating capacity powered by atomic fuel and 100,000,000 kw by 1985.

Textile Industry Electrical Equipment Conference Scheduled for November 3–4

THE ELECTRICAL EQUIPMENT for the Textile Industry Conference is scheduled for November 3–4, at the North Carolina State College in Raleigh, N. C. Registration will take place Thursday morning, November 3, from 9:30 a.m. to 1:00 p.m. The tentative technical program for the conference is as follows:

Thursday, November 3

Morning Session

10:00 a.m. Tour of School of Textile and Electrical Engineering Laboratories

Afternoon Session

Presiding: J. T. Meador, Southern Electric Service Company

1:00 p.m. Address of Welcome: *J. H. Lampe*, North Carolina State College

Proposed Recommended Practices for Electrical Installations on Textile Machinery. *R. H. Clark*, Warner and Swasey Company

Electrical Features of Air Conditioning in Textile Mills. *J. de B. Sheppard*, P. L. Davidson Company

The Co-ordination of Current Limiting Fuses and Air Circuit Breakers. *M. S. Carlson*, ITE Circuit Breaker Company

Practical Problems of Applying Circuit Protectors in the Textile Industry. *H. B. Grear*, General Electric Company

3:45 p.m. Discussion of preceding papers

4:00 p.m. Social Hour, Tarheel Club

7:00 p.m. Barbecue Dinner, Tarheel Club

Friday, November 4

Morning Session

Presiding: H. A. Dameron, Jr., Synthetics Division, J. P. Stevens and Company

9:30 a.m. Additional Comments on "Proposed Recommended Practices for Electrical Installations on Textile Machinery" and Its Reception at the Recent AIEE Meeting in Swampscott, Mass. *F. D. Snyder*, Westinghouse Electric Corporation

Factors Affecting the Cost of Low-Voltage Power Distribution Systems in Textile Mills

New Construction. *Howard Pawcatt*, Bryant Electric Company

Revamping Old Mills. *J. R. Rutledge*, Huntington and Guerry

Surge Protection for Rotating Machinery in Textile Plants. *E. W. Beck*, Westinghouse Electric Corporation

Report of Conference Committee. *J. T. Meador*, Southern Electric Service Company

12:30 p.m. Luncheon: College Union Building, North Carolina State College

Presiding: K. T. Knight, Chairman, North Carolina Section, AIEE

Afternoon Session

Presiding: Dan McConnell, Cone Mills Corporation

2:00 p.m. Why We Need "Recommended Practices for Electric Installations on Textile Machinery," *Swayfield Cowan*, Factory Insurance Association

My Day-To-Day Electrical Problems in Textile Plants—*E. P. Taylor*, Carter Fabrics Division, J. P. Stevens and Company

3:00 p.m. Panel: Electrical Problems and Their Remedies also Discussion of "Recommended Practices for Electric Installations on Textile Machinery." Moderator: Dan McConnell, Cone Mills Corporation

Panel to be composed of all speakers and, in addition, to include Dr. George Hoadley.

Nomination of AIEE Officers to Be Voted Upon for '56

For the nomination of officers to be voted upon in the spring of 1956, the AIEE Nominating Committee will meet in New York, N. Y., January 30, 1956. The officers to be elected are: a president, a treasurer, three directors, and six vice-presidents, one from each of the odd-numbered geographical Districts. Fellows only are eligible for the office of President; Fellows and Members for the offices of Vice-President, Directors, and Treasurer.

To guide this committee in performing its constituted task, suggestions from the membership are, of course, highly desirable. To be available for consideration of the committee, all suggestions must be received by the Secretary of the committee at Institute headquarters not later than December 15, 1955.

In accordance with the provisions in the constitution and bylaws, quoted in the following paragraphs, actions relating to the organization of the Nominating Committee are now under way:

Constitution

30. There shall be constituted each year a Nominating Committee consisting of one representative of each geographical District, elected by its executive committee, one representative of each technical division elected by the division committee, and other members chosen by and from the Board of Directors not exceeding in number the number of technical divisions; all to be selected when and as provided in the Bylaws. The Secretary of the Institute shall be the secretary of the Nominating Committee, without voting power.

31. The executive committee of each geographical District shall act as a nominating committee of the candidate for election as vice-president of that District, or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

32. The Nominating Committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The Nominating Committee shall name, on or before January 31 of each year, one or more candidates for president, treasurer, and the proper number of directors, and shall include in its ticket such candidates for vice-presidents as have been named by the nominating committees of the respective geographical Districts, if received by the Nominating Committee when and as provided in the Bylaws; otherwise the Nominating Committee shall nominate one or more candidates for vice-president(s) from the District(s) concerned.

Bylaws

Sec. 27. During September of each year, the secretary of the Nominating Committee shall notify the chairman and secretary of the executive committee of each geographical District, and the chairman and secretary of each technical division committee, that, by December 15 of that year, each District and each technical division should select a representative to serve as a member of the AIEE Nominating Committee and an alternate to serve if the representative is unable to attend the meeting of the Nominating Committee. The names of representatives and alternates, so selected, should be transmitted by the above designated officers to the secretary of the Nominating Committee by December 15.

During September of each year, the secretary of the Nominating Committee shall notify the chairman and secretary of the executive committee of each geographical District in which there is, or will be during the year, a vacancy in the office of vice-president that by December 15 of that year, a nomination for a vice-president in

that District made by the District executive committee should be in the hands of the secretary of the Nominating Committee.

Between October first and December fifteenth of each year, the Board of Directors shall choose a number of its members, not exceeding the number of technical divisions, to serve on the Nominating Committee, and notify the secretary of the Nominating Committee of the names of the members so chosen.

The secretary of the Nominating Committee shall give the members so selected not less than ten days' notice of the first meeting of the committee, which shall be held not later than January thirty-first. At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. To insure that full consideration be given to all suggestions from the general membership, they must be in the hands of the secretary of the committee by December fifteenth. The nominations as made by the Nominating Committee shall be published in the March issue of *Electrical Engineering*, or otherwise mailed to the Institute membership not later than the first week in March.

Independent nominations may be made in accordance with provisions in article VI, section 33, of the constitution and section 28 of the Bylaws, which are quoted in the following:

Constitution

33. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the secretary when and as provided in the Bylaws; such petitions for the nomination of vice-presidents shall be signed only by members within the District concerned.

Bylaws

Sec. 28. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with article VI, section 33 (Constitution), must be received by the secretary of the Nominating Committee not later than March 25 of each year, to be placed before that committee for the inclusion in the ballot of such candidates as are eligible.

On the ballot prepared by the Nominating Committee in accordance with article VI of the Constitution and sent by the secretary to all qualified voters on or before April 15 of each year, the names of the candidates shall be grouped alphabetically under the name of the office for which each is a candidate.

(*Signed*) N. S. Hibshman
Secretary

Magnetics Conference a Success; Proceedings Are Now Available

THE CONFERENCE on Magnetism, held in Pittsburgh, Pa., at the William Penn Hotel, June 14–16, was successful. Two things that helped make it a success, and which may be of interest to others arranging conferences, were the publication of abstracts of papers prior to the meeting and the exhibit of items related to the subject of the conference. The abstracts gave a good idea of what could be expected in a particular field and enabled preparation of interesting discussions.

Papers presented at the conference are being published in the *Proceedings* and these may be obtained from AIEE Headquarters, 33 West 39th Street, New York, N. Y., at the postconference price of $8.00.

Registrants represented a good cross-section of all types of workers in the field of magnetism—from basic research through application to devices and ultimate production and testing of commercial magnetic materials. Conference subjects covered the same range of interest and included sessions on basic theory and basic experimental work, metallurgy and crystal structure, permanent magnet materials, high-frequency core materials and various aspects of testing methods, special properties of materials for particular applications, and detailed analyses of magnetic behavior in a number of applications, all of which were competently presented.

Through the assistance of R. Rimbach Associates, an exhibit of magnetic materials and test equipment now in production by several suppliers was presented. The exhibit was small but was proposed and carried out to determine whether such an exhibit aids the objectives of a conference. Conclusion of exhibitors and those attending was that this was a valuable addition to the conference.

It also enabled those attending to discuss their problems with exhibitors.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until *November 30*. Duplicate double-spaced typewritten copies of each discussion should be sent to Edward C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., on or before *November 30*.

55-276 Two-Axis Method of Analyzing Electric Machines. *K. Y. Tang, R. L. Cosgriff*

55-531 Electrical Utility Load Forecasting. *W. W. Godard*

Preprints may be purchased at 30¢ each to members, 60¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th Street, New York 38, N. Y.

Electrical Techniques in Medicine, Biology Conference Is Scheduled for this Month

THE EIGHTH ANNUAL CONFERENCE on Electrical Techniques in Medicine and Biology will be held this month, November 14–16 (Monday through Wednesday), at the Shoreham Hotel in Washington, D. C. Sponsors are the AIEE, the Institute of Radio Engineers, and the Instrument Society of America. The purpose of the conference is to provide liaison and better understanding among workers in electronic engineering, medical research, and related fields to advance development and application of electrical techniques in medicine and biology.

Three technical sessions are scheduled—one for each day of the conference. Four papers on "Recent Advances in Angiocardiography" will be presented on the morning of November 14. Chairman of the session will be Theodore F. Hilbish, M.D.; M. P. H., chief, Diagnostic Radiological Service, National Institutes of Health, Bethesda, Md. Theme of the four papers to be presented the following morning will be "Audiology and Instrumentation for Hearing." Chairman will be Dr. Scott Reger, Department of Otolaryngology, University of Iowa Hospital, Iowa City. Six papers concerning "Instrumentation in Medicine and Biology" will be presented Wednesday morning with W. A. Wildhack as chairman.

Mr. Wildhack is chief of the Office of Basic Instrumentation, National Bureau of Standards, Washington, D. C.

Each afternoon there will be an inspection trip. On Monday conference registrants may visit the National Institutes of Health, Bethesda; on Tuesday, the Naval Medical Research Institute, Bethesda; and on Wednesday, the National Bureau of Standards, Washington.

Institution of Engineers, Australia, Invites AIEE Members to Visit

C. H. D. Harper, Secretary of The Institution of Engineers, Australia, has written to AIEE Secretary N. S. Hibshman inviting AIEE) members to visit Australia during the 1956 Olympic Games. In part, his letter is as follows:

"As you are aware, the 1956 Olympic Games will be held in Melbourne in November next year.

It seems quite possible that some of your members may be attending as competitors, officials or visitors, and the members of this Institution would be very glad of the opportunity to extend hospitality to them. Should any such visitors desire to inspect engineering works or industries in the State of Victoria, we will be very pleased to make the necessary arrangements to enable them to do so.

It would be greatly appreciated if you would bring to the notice of your members our desire to welcome them if they visit Melbourne next year, and it would also be

greatly appreciated if they would write to the Hospitality Officer, The Institution of Engineers, Australia, Kelvin Hall, 55 Collins Place, Melbourne, giving details of the time they will spend in Australia, their particular interests, and anything they would particularly wish to see."

World Power Conference Plans Fifth Plenary Meeting for 1956

United States engineers, scientists, industrialists and government representatives will present 25 papers on the development of atomic energy, steam and gas turbines, and related subjects of power and fuel technology at the fifth plenary meeting of the World Power Conference (WPC). The conference is scheduled for June 17–23, 1956, in Vienna, Austria. General theme of the conference will be "World Energy Resources in the Light of Recent Technical and Economic Developments." Gail A. Hathaway, chairman of the United States National Committee, made this announcement recently.

Most of the 45 member nations are expected to participate. The Atomic Energy Commission, Bureau of Mines, Bureau of Reclamation, Corps of Engineers, Federal Power Commission, and Rural Electrification Administration are members of the U. S. National Committee and representatives of several of these agencies will present papers. AIEE is one of the many societies on the U. S. National Committee. This country's participation details are being arranged at the headquarters of the United States National Committee, 29 West 39th Street, New York, N. Y.

Preparations are being made for an attendance of 2,000. The Austrian Government plans to invite all nations with which it has diplomatic relations to be represented at the conference by official designees. Similar invitations will be extended to intergovernmental and nongovernmental international organizations by the Austrian National Committee, headed by Franz Holzinger.

Unprecedented interest is being shown in the forthcoming meeting by government and nongovernmental agencies, societies, companies, and individuals because of the tremendous advances since the last plenary session in 1950 and in view, further, of the great field of development ahead.

Water, oil, coal, and atomic power will be among topics discussed in the United States' contributions to the program. Care has been taken so that the program will have a sufficiently broad scope to accord with present tendencies toward closer interrelationship in methods of production and uses of power. The conference will try to present problems that are of greatest current general interest. A free choice is permitted the participating nations in the presentation of subjects within the scheduled divisions and sections of the program. These divisions are:

1. State and development of power production and utilization in individual countries
2. Preparation and conversion of fuels
3. Utilization of primary sources of energy
4. Purification of waste water and waste gas in the production and use of energy
5. International collaboration in the production and use of energy

Each of these divisions is divided into sections. Gail A. Hathaway, chairman of the United States National Committee, is past president of the American Society of Civil Engineers. He is vice-president of the International Executive Council of the World Power Conference and is also president of the International Commission on Large Dams. He is special assistant to the chief of engineers, U.S. Army. Stuart M. Crocker of New York, chairman of the board of Columbia Gas System, Inc., is vice-chairman of the U. S. National Committee. Brigadier General Stewart E. Reimel (retired) is secretary. Sir Harold Hartley is president of the WPC, which has headquarters in London, England.

Plenary meetings of WPC are held every 6 years. Interim sessions, referred to as Sectional meetings, are scheduled regionally at 2-year intervals.

2,000 Attendance Expected at Nuclear Congress, Atomic Show

An opportunity to look at our progress in atomic energy and its applications for peaceful, productive purposes will be possible at the Nuclear Engineering and Science Congress in Cleveland, Ohio, December 12–16. The conference will provide the first real opportunity for the general public to understand the massive impact of atomic energy on our economy. An Atomic Exposition will supplement the discussions of nuclear developments—reactors, components, equipment, materials and services in the atomic power field. The exposition is sponsored by the American Institute of Chemical Engineers and will include first displays of nuclear equipment open to the public. The exposition will be open December 10 and 11.

Thorndike Saville, president of Engineers Joint Council, said: "... this highly interrelated family of developments (peaceful application of atomic developments) is, as yet, very much in the 'idea for application' stage. Therefore, it is of enormous importance to present ... a panoramic view with detail as a proper measure of current opportunity and the vastness of potential. Progress for the Conference already indicates that it will be the largest gathering of engineers and scientists ever held in the United States to discuss nuclear energy..."

More than 2,000 representatives of industry, Government, and education are expected. Three-hundred papers are to be presented, some of these by AIEE members.

Nuclear energy and its products are already used by more than 3,000 industrial firms in the United States. Though impressive, this is a small part of potential application. This is demonstrated by the tremendous range of interest of participants in the congress. Sponsoring groups coordinated in this effort by Engineers Joint Council and its constituent societies involve half a million engineers and scientists representing, the following fields: mining metallurgy, sanitation, water supply, radio, electronics, chemical, petroleum, steel, nonferrous metals, aviation, automobile manu-

New Officers of Georgia Section

NEW OFFICERS OF AIEE's Georgia Section are (left to right): T. J. Allen, vice-chairman; J. C. Ager, chairman; and Frank Willett, secretary-treasurer. Mr. Allen is superintendent of transmission, Georgia Power Company; Mr. Ager, Georgia manager, General Electric Company; Mr. Willett, utilities representative, State of Georgia, Westinghouse Electric Manufacturing Company.

facture, rockets, architecture, ships, road construction, and city planning.

The cosponsoring societies who are cooperating with Engineers Joint Council in this congress are the American Chemical Society, American Institute of Physics, Institute of Radio Engineers, American Nuclear Society, American Geological Institute, American Society for Metals, American Rocket Society, Institute of Aeronautical Sciences, Atomic Industrial Forum, Society of Automotive Engineers, and the American Society for Testing Materials. The Cleveland hosts for the Congress are the Cleveland Engineering Society and the Cleveland Technical Societies Council.

AIEE FELLOWS ELECTED..

Board of Directors Meeting, August 17, 1955

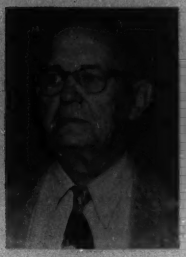
Martin Francis Beavers (AM '31, M '40), development engineer, distribution transformer advance and development engineering, General Electric Company, Pittsfield, Mass., has been transferred to the grade of Fellow in the AIEE "for his contributions to the understanding and better design of inductive apparatus, particularly in the field of dielectric and heat transfer." Mr. Beavers was born on May 15, 1905 in Cuba, Ala., attended Alabama Polytechnic Institute, from which he graduated, receiving a bachelor of science degree in electrical engineering in 1926. He then joined the General Electric Company as a student engineer. From 1927 to 1929 he was in the Pittsfield plant as requisition designer of pole-type distribution transformers. He was advanced to the insulation and heat transfer department where he developed winding arrangements and insulating structures to improve dielectric strength, heat transfer, and resistance to thermal degradation. In this capacity, he also developed an improved means for heat radiation. In 1941, Mr. Beavers was commissioned an officer in the U. S. Army in which he remained until 1945. During this period, he wrote an article for the June 1941 issue of the *Field Artillery Journal* entitled, "Quick, Where Am I? (Resection Method)." He returned to General Electric in Pittsfield as insulation and heat transfer engineer, staying in the distribution transformer engineering section until 1953. He later was promoted to development engineer in the distribution transformer advance and development engineering section, where he worked on improving means for testing the thermal characteristics of transformers, coordination of overload protective devices with transformer thermal characteristics, and improving means for heat radiation. He has written several technical papers, some of which follow: "Simultaneous Single-Phase and Three-Phase Loading on Isolated Wye-Delta Transformer Banks," *General Electric Review*, October 1934; "Selecting Distribution Transformer Size," *Electrical Engineering*, October 1940; "Simple Foolproof Production Tester," *Electronics*, February 1947; "Measurement of Ambient Temperature During Test on Transformer," *AIEE Conference Paper 1953;* and "Increased Use of Transformer Capacity Suggested in American Standards Association Guide," *Electrical World*, April 4, 1955. He has been collaborator and coauthor on other published articles. He is a member of the National Society of Professional Engineers, and chairman of the Berkshire Chapter of the Massachusetts Society of Professional Engineers. Mr. Beavers also is an active member of the AIEE Committee on Transformers.

W. F. Beavers

Charles Earle Dean (AM '23, M '37), editor and writer with the Hazeltine Corporation, has been transferred to the grade of Fellow in the AIEE "for contributions to literature in the field of communications, particularly television." He was born in Pickens County, S. C., on May 23, 1898. He received a bachelor of arts degree in 1921 from Harvard College, a master's degree in 1923 from Columbia University, and a doctor's degree in 1927 from Johns Hopkins University. He joined the Western Electric Company, New York, N. Y. (later Bell Telephone Laboratories), as an engineering assistant in the engineering department in 1921. He was a physicist in the department of otolaryngology at Johns Hopkins Medical School, 1924–1926, and became affiliated with the American Telephone and Telegraph Company, New York, N. Y., as technical writer in 1927. He continued with that firm until 1929 when he joined the Hazeltine Electronics Corporation, subsidiary of the Hazeltine Corporation, Little Neck, N. Y. From 1929 until 1942, Dr. Dean was a radio engineer engaged in evaluating patents, investigating infringement rights cases, and writing monthly bulletins on advances in radio engineering. In 1937, he was awarded a U. S. patent for his tone control system. From 1942 through 1952 he was in charge of the publications department consisting of more than 90 persons whom he directed in writing instruction books for the armed forces, issuing weekly summaries of technical articles in a series called "The Hazeltine Scope," and in editing other company publications and reports. The U. S. Navy awarded him its Certificate of Commendation in 1947 for his outstanding supervision and unremitting effort in the preparation and delivery of instruction books on radio equipment. These set standards of excellence of such high degree that the books were considered exemplary as to content, format, arrangement, and usefulness both by maintenance personnel and instructors in Naval radar schools. Since 1952, Dr. Dean has been staff editor and writer, collaborating on a textbook, "Principles of Color Television." This text will be published by John Wiley and Sons, New York, N. Y. Each chapter has been released to Hazeltine licensee firms and engineering schools, thus contributing to the technical education of the industry in the rapidly advancing field of color television. Dr. Dean is a member of the Institute of Radio Engineers, the Radio Club of America, and the Society of Motion Picture and Television Engineers. His many published articles include: "Audition by Bone Conduction," *Journal of the Acoustical Society of America*, 1930; "Bandwidth Factors in Cascade Tuned Circuits," *Electronics*, July 1941; section on "Receiving Systems," *Radio Engineering Handbook*, 1950; and "Tuner for Complete UHF-TV Coverage Without Moving Contacts," which he coauthored with R. J. Lindeman, *Proceedings of the Institute of Radio Engineers*, January 1953. Dr. Dean has served on various AIEE committees among which were: Publication (1942–44, 1954–55), Communication (1948–49), Aural Broadcasting Systems (1949–50), Television and Aural Broadcasting Systems (1950–55, chairman, 1952–53), and Prize Awards (1954–55).

C. E. Dean

Wendolyn F. Gakle (AM '35, M '43), vice-president, and chairman, operating committee of Kuhlman Electric Company, Bay City, Mich., has been transferred to the grade of Fellow in the AIEE "for pioneering developments in transformer design, particularly the use of grain-oriented steel in cores." Mr. Gakle was born March 7, 1882, in Chicago, Ill. He attended St. Vincent High School, Elkhart, Ind., graduating in 1897. He continued his education with an engineering course given by the International Correspondence School, 1898. From 1897 to 1898 he worked in the LaKon Transformer Manufacturing Company fac-



W. F. Gakle

J. T. Hawley

H. E. Murphy

tory in Elkhart, Ind. He became assistant to the chief engineer at LaKon and designed transformers and associated equipment from 1898 through 1900. At that time, he was promoted to chief engineer, and from 1900 to 1903 was in complete charge of designs of transformers and allied equipment. In 1903, Kuhlman Electric Company purchased LaKon and Mr. Gakle was made design engineer for the combined operations until 1905. He was appointed chief engineer in 1905 and continued in that position until 1944. In the early part of this span, he also acted as general superintendent. This enabled him to contribute many original designs to the rapidly growing electrical industry. Some of these were developments in reactors for the carbon-arc motion picture projector, air-core reactors for elevator controls, and 3-to-single phase power supplies for arc furnaces. He was in close contact with developments in the distribution field, and made significant contributions in the series-multiple street lighting transformers. In 1933 Mr. Gakle was awarded a patent for his prototype of the with-grain transformer core construction, which is used in nearly all present transformers in one form or another. Since 1944, he has held his present office and also is a director for the firm. His chief interest in his present position is in engineering, research, and development.

John Terrill Hawley* (M '19), chief electrical engineer, sanitary district of Chicago, Ill., has been transferred to the grade of Fellow in the AIEE "for contributions to the application of electricity to the sanitary system of a large metropolitan area." John Hawley was born August 7, 1886 in Connecticut. He has been with the sanitary district of Chicago for 45 years. For the past 30 years, he has been in complete charge of the district electrical system. He was the designer and supervised the construction of all electrical equipment. The system originally furnished electricity for all municipal services for the City of Chicago and surrounding Cook County towns, as well as more than 15,000 domestic and industrial consumers. The hydroelectric powerhouse in Lockport, the steam-generating units in Chicago, 450,000 feet of 33,000-volt circuits, the substations, 900,000 feet of 12,000-volt underground transmission lines, and various distribution lines have now been integrated with the Commonwealth Edison system under Mr. Hawley's supervision. He was also engineer in charge of the building of movable bridges, controlling works, ship locks, several pumping stations, and three large sewage treatment plants, all of which cost more than $300,000,000. He has been in direct charge of the design specifications, construction, operation and maintenance of all electrical equipment in many plants throughout the area. Many of the building plaques bear Mr. Hawley's name as electrical engineer. In these plants there are more than 30 motors rated at 6,600 volts and 12,000 volts, 1,000 hp to 2,000 hp, and more than 3,000 motors rated at 110 volts and 440 volts in various sizes up to 400 hp. One plant has a capacity for supplying 7.1-million pounds of steam per minute with generating units fired by powdered coal. All equipment, some electronic, is electrically interlocked. And, this plant has a capacity of one-billion gallons per day, centrifugal air compressors with a total capacity of 500,000 cu ft per minute. He redesigned the 33-kv transmission lines, changing them from aluminum to copper conductors, and thus maintaining continuous service with no break-downs—only necessary suspension for a few minutes for reclosing. Two 10,000 hp variable-pitch propeller vertical units replaced two smaller horizontal hydroelectric units. This included complete redesign and replacement of nearly all low-voltage control and high-voltage switching equipment in the powerhouse. He supervised the hydraulic and electrical equipment design and construction. Mr. Hawley also has designed and applied electrical equipment, such as electrically-heated blades on large 250-hp motor driven circulating fans, for which he has submitted designs for patent.

*Mr. Hawley's transfer to grade of Fellow was approved by the Board of Directors on April 14, 1955.

Howard Elvyn Murphy (M '40), consulting engineer, Cohasset, Mass., has been transferred to the grade of Fellow in the AIEE "for contributions to the application of electrical engineering to the problems of industry." He was born in Huron, Ind., August 31, 1888. He received his technical education at Rose Polytechnic Institute and the Massachusetts Institute of Technology. He joined Stone and Webster Engineering Corporation in 1907, working as electrician on projects in Indiana and Massachusetts. From 1909–10, Mr. Murphy was affiliated with the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., and Chicago, Ill., working as a trouble shooter on electrical, steam, and hydro equipment in the testing department. He rejoined Stone and Webster, working as electrical superintendent from 1910 to 1915 on power plant constructions in Minneapolis, Minn.; Tampa, Fla.; Keokuk, Iowa; Peekskill, N. Y.; and Worcester, Mass. He became chief engineer for the Luminous Unit Company (now Edwin F. Guth Company) in 1915, developing light fixtures and their application, and was advanced to the position of vice-president and general manager of the Missouri Radio Corporation (a Guth subsidiary). In 1924 he rejoined Stone and Webster to do engineering in the electrical division of the firm which was in the process of building many large office buildings and manufacturing plants in the East, as well as a cable station in the Azores. In 1926, he was promoted to electrical engineer, which put him in responsible charge of approximately 90 projects. This assignment necessitated the development of new equipment or the improvement of those available. Among the projects which were in progress at the time of this assignment and subsequently were: the Lever Brothers Company soap and edible products plants, Hammond, Ind.; Edgewater, N. J.; Cambridge, Mass.; and Baltimore, Md.; the General Motors Corporation assembly plants Uruguay and Argentina; Mathieson Alkali Works, Inc., power and chemical plants, Virginia and Louisiana; City of Boston, consulting services for vehicular tunnel; Blackstone Valley Gas and Electric Company, public utility; and the U. S. Navy submarine base, New London, Conn., generating, battery charging, and power distributing. Mr. Murphy is a member of the Massachusetts Society of Professional Engineers, the California Society of Professional Engineers, and the Engineering Society of New England. He is a registered professional engineer in the states of Massachusetts, Connecticut, and California.

Gorden Curtis Nonken (AM '36, M '45), supervisor—mechanical subsection, transformer laboratories department, General Electric Company, Pittsfield, Mass., has been transferred to the grade of Fellow in AIEE "for a diversity of contributions in the field of measurements and manufacturing processes, particularly as applied to transformers and capacitors." He was born July 1, 1908, in Burns, Kans., and obtained a bachelor's degree in electrical engineering from Kansas State College in 1930. He became a test engineer for General Electric Company, Schenectady, N. Y., where he checked the performance of motors, transformers, rectifiers, and circuit breakers,

G. C. Nonken

R. J. Salsbury

from 1930 to 1931. He also conducted a research project on high-voltage d-c transmission in the research laboratory under the direction of Dr. C. H. Willis, head of electrical engineering, Princeton University, where he completed a year of the advanced engineering course. From 1931–1941, Mr. Nonken was project engineer at General Electric, Pittsfield, Mass., where his substantial contributions to the original development of test equipment and methods for determining corona in insulation have provided the basis for present methods and designs of all transformers, as well as capacitor insulation. During this period, he worked on applications and uses of Rescon in high-voltage apparatus, application of the cathode-ray oscillograph as a device to make field demonstrations of impulse-voltage distribution in transformer coils, the comprehensive study of high-pressure gases as dielectrics, and an original study in application of high-frequency dielectric heating. In 1941, he was promoted to the position of industrial heating engineer, giving him the responsibility of the engineering of industrial heating equipment at the Pittsfield plant. His responsibility was for the design of furnaces to anneal grain-oriented strip steel-wound cores for transformers, and the development, design, and building of electric furnaces for continuous process melting of glass, the promotion of centrifugal casting of glass bushings to supersede still casting, as well as many other developments. In 1947 he was promoted to assistant supervisor, mechanical section, works laboratory. In this capacity, he was responsible for plant processes and laboratory functions in silicon steel annealing methods and equipment; copper wire (single strand electric) annealing, film insulation extrusion, Formex application and curing, and high-frequency heating of wire; and stress analysis including improved instrumentation for measurement of dynamic forces in transformers. In 1952, he became supervisor of the section in which 25 engineers and assistants worked on various manufacturing process developments. Mr. Nonken was given General Electric's Coffin award. He obtained a patent for a temperature control system in 1943, and another in 1953 for a combined electrode and skimmer for electric glass melting furnaces. Also, he has written the following technical papers: "High Pressure Gas as a Dielectric," *AIEE Transactions*, 1941; "Electronic Heating of Non-Conductors," *Paper Trade Journal*, February 1944; "Effect of Gas Atmosphere on Furnace Heat Losses," *Steel Processing*, July 1948; and "Production of Oriented Single Crystal Silicon Iron Sheet," *Metals Progress*, December 1953. Mr. Nonken is a registered professional engineer in Massachusetts.

Raymond Jay Salsbury (AM '19, M '34), manager, operating and tests section, Duquesne Light Company, Pittsburgh, Pa., has been transferred to the grade of Fellow in AIEE "for contributions to protection, standardization, testing, and development of power system equipment." He was born in Breckenridge, Mo., on April 4, 1891. He received a bachelor of arts degree from Park College, Parkville, Mo., in 1912, and was class valedictorian. He also obtained a bachelor of science degree in electrical engineering from Carnegie Institute of Technology in 1917. He joined Pittsburgh Railways Company as chief electrician, responsible for the maintenance, operation, design, and construction of substations for conversion of alternating current to direct current in approximately 15 stations with a total of about 30,000 kw. Mr. Salsbury studied and designed railway negative feeder systems for diminishing electrolysis. In 1925, he became superintendent of operations for the substations and shops department of the Duquesne Light Company, Pittsburgh, where he was in charge of operations for 35 attended stations, 30 automatic stations, 200 industrial stations, and 200 men. He inaugurated a program of education for operators of substations, and initiated a program of routine calibration, testing, and repairing relays with attendant keeping of statistical records to determine performance of the program. He remained in this capacity until 1939 when he was promoted to superintendent of tests. In this capacity, he was in charge of lightning protection and insulation co-ordination which involved laboratory testing on a surge generator of some 700-kv capability, with cathode ray oscillograph and associated equipment. His responsibility also covered relay operation, maintenance, and applications; transformer specifications, repair, modernization, thermal capabilities, rating, and application; oil circuit breaker testing and applications, in the laboratory and in the field, and investigating the effect of recovery voltage on breaker capability. Mr. Salsbury was promoted to the position of manager, operating and tests section, substations and shops department, in 1953, where he is responsible for the capital and operating budgets which are approximately $1,000,000 and $1,200,000 per year, respectively. He has collaborated with a manufacturer in the developement of a load interpreter switch used throughout the industry. This switch has permitted the use of enclosed switching transmission voltages up to 34.5 kv. Mr. Salsbury's studies of thermal capability of transformers has permitted increased loads on utility systems, thus resulting in economies throughout the industry. His contributions to the standardization of bushings for transformers, especially the bulk or dry-type for 23 kv transformers are virtually maintenance free, and have been adopted as standard. He is a member of the Engineers' Society of Western Pennsylvania, the Pennsylvania Electric Association, and the Edison Electric Institute. He is a registered professional engineer in Pennsylvania.

AIEE PERSONALITIES.....

Philip Sporn (AM '20, F '30), president, American Gas and Electric Service Corporation and the American Gas and Electric Company, New York, N. Y., has been awarded the John Fritz Medal for 1956. He has been cited "... as distinguished engineer, pioneer in utility engineering practice, eminent executive, and human administrator." Mr. Sporn was born in Galicia, Austria, November 25, 1896. He received the degree of electrical engineer from Columbia University, New York, N. Y., in 1917. That same year he became associated with the Crocker-Wheeler Electric Manufacturing Company's test department in Ampere, N. J., and remained with the company until 1919. Then he joined the staff of the Consumers Power Company, Jackson, Mich., as a technical assistant in the electrical engineering department engaged in station and substation design work. Mr. Sporn began working for the American Gas and Electric Service Corporation in 1920 progressing from protection engineer to executive vice-president for 15 subsidiary companies and then to the presidency of the parent organization in 1947. In 1928, he received the AIEE national first prize in the engineering practices field for his paper, "Rationalization of Transmission System Insulation Strength." He developed the ultrahigh-speed closure circuit breakers as a means of furthering the stability and dependability of high-voltage transmission circuits in 1937. His work in the application of hydrogen to the cooling of alternators and synchronous condensers pioneered later developments. Mr. Sporn was instrumental in effecting several installations of the heat pump on the American Gas system as an indispensable element in the complete electrification of the home. During World War II, he was a consultant with the War Production Board for which he prepared a comprehensive report on the use of silver as a substitute for copper and aluminum as electrical conductors. In 1945, he

Philip Sporn

W. P. Dobson

W. C. White

received the AIEE Edison Medal "for his contributions to the art of economical and dependable power generation and distribution." The Columbia University Engineering Alumni Association awarded him the Egleston Medal "for distinguished engineering achievements." He is a member of The American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Society for Testing Materials, the Franklin Institute, the American Society for the Advancement of Science, Sigma Xi, and Tau Beta Pi. Mr. Sporn is an active member of AIEE and has served on the following Committees: Power Transmission and Distribution (1927–28, 1929–43, chairman 1941–43), Transmission and Distribution (1944–47), Research (1932–36), Production and Application of Light (1933–34), Power Generation (1933–39), Technical Program (1941–43), Standards (1941–43), Award of Institute Prizes (1942–43), Lamme Medal (1944–47), Edison Medal (1948–53), and Special Committee on the Use of Silver as a Substitute for Copper and Aluminum in Electrical Installations (January 1943–August 1944, chairman).

W. P. Dobson (AM '13, F '43), director of research, Hydro-Electric Power Commission of Ontario, Toronto, Ontario, Canada, was given a testimonial dinner on the occasion of his retirement. He had been consultant and liaison officer on atomic energy at the Commission. From a staff of seven in 1914, the research division has grown to approximately 300 men, 100 of whom are professional engineers and scientists, under the guidance of Dr. Dobson. He has been actively engaged in standardization work in Canada, and elsewhere. He was a member of the first standardization committee of the Canadian Standards Association in 1919. In the international standardization field, he has served on many committees of the AIEE and the American Society for Testing Materials. He is a member of the Canadian National Committee and also the U. S. National Committee of the International Electrotechnical Commission, an organization comprised of more than 30 countries. He has represented Hydro-Electric in various organizations, such as the Canadian Radio Technical Planning Board, which is an association of government departments and industrial interests in Canada. He is a registered professional engineer in Ontario, and a member of the Ontario Association of Professional Engineers of which he was elected president in 1939. He has received the following awards: the University of Toronto Engineering Alumni Medal, honorary life membership in the Canadian Standards Association, honorary Canadian presidency of the International Association of Electrical Inspectors, and the 1951 honorary degree of doctor of science from Queens University, Kingston, Ontario. He has been on the following AIEE Committees: Research (1922–24, 1927–32), Edison Medal (1925–27), Executive (1926–27), Standards (1938–55, chairman 1945–47), Planning and Co-ordination (1945–47), Technical Program (1945–47), Safety (1945–46, 1948–55).

W. C. White (AM '23, F '47), electrical engineer, Research Laboratory, The Knolls Atomic Power Laboratory, General Electric, Schenectady, N. Y., was honored with a dinner upon his retirement after 43 years with the company. He was graduated from Columbia University in 1912 and joined General Electric where he was actively engaged in the development of the electron tube. In 1930, he was appointed head of the vacuum tube engineering department, and became engineer of the electronics laboratory established in 1942. In 1944, he was promoted to electronics engineer of the Research Laboratory. Besides membership in AIEE, he has served as chairman of the board for the National Electronics Conference, and was a former director of the Institute of Radio Engineers. **L. A. Hawkins** (AM '03, M '13), retired, executive engineer, Research Laboratory, General Electric, served as master of ceremonies at the dinner. Mr. White has served on the following Institute Committees: Electrophysics (1931–33), Communication (1935–46, 1948), Electronics (1942–55, chairman 1944–45), Standards (1944–45), Technical Program (1944–45), Special Advisory to AIEE Representative on Radio Technical Planning Board (1945–48, chairman), and National Electronics Conference Representative (1946–49).

John B. Russell (AM '34, F '51), professor of electrical engineering at Columbia University, New York, N. Y., is now consultant with the Electronics Laboratory of General Electric Company, Syracuse, N. Y.

Henry R. Stoddard (AM '50), sales engineer, Simplex Wire and Cable Company, Chicago, Ill., has been transferred to the Cambridge Mass., engineering staff. After receiving a bachelor of science degree in electrical engineering from Norwich University, he joined Simplex in the electrical engineering laboratory. Mr. Stoddard has been with the company for 28 years, and this move will utilize his experience with problems of cable engineering in a wider field.

H. S. Osborne (AM '10, F '21), retired, past president, American Telephone and Telegraph Company, New York, N. Y., has been decorated by the Government of Sweden as "Knight of the Royal Order of Vasa, First Class," in recognition of services in assisting the Swedish Department of Telecommunications. The ceremony took place in Stockholm. Dr. Osborne is a past president of the International Electrotechnical Commission. He also is a past president of AIEE (1942–43), and past Director (1938–42). He has been on the following Committees of the Institute: Standards (1917–28, chairman 1923–26, ex-officio 1949–50), Standards Council, American Standards Association (Representative: 1923–28, 1931–33, 1939–40, 1942–44, 1947; Alternate: 1928–31, 1934–39, 1941), U. S. National Committee of International Electrotechnical Council (Representative: 1923–42; Alternate: 1931–32), Technical Program (1924–25; 1927–29; 1931–34; 1936–41, chairman 1936–39), Education (1928–31), Communication (1929 37, chairman 1931–34), Electrical Standards Committee, American Standards Association (Representative 1932–42, Alternate 1931–32), Edison Medal (1935, 1942–43, 1947–52), Award of Institute Prizes (1936–40, chairman 1936–39), Publication (1936–39), Alfred Noble Prize, American Society of Civil Engineers (1937–42), Council, American Association for the Advancement of Science (1938, 1939), Co-ordination of Institute Activities (1936–38), Planning and Co-ordination (1938–42, 1945–49), Institute Policy (1938–42), Headquarters (1939–42), Legislation Affecting the Engineering Profession (1939–41), Finance (1939–42, chairman), Executive (1939–45, chairman 1942–43), Charles A. Coffin Fellowship and Research Fund (1942–43), John Fritz Medal Board of Award (1942–46), Executive Committee of United States National Committee to World Power Conference (1942–43), AIEE Retirement System—Board of Trustees (1943–45), Hoover Medal Board of Award (1945–51), Volta Scholarship Trustee (1949–55, chairman,) and liaison representative on Standards (1952–54). Dr. Osborne has also served on the following special committees: For Consideration of the Broadening of Institute Activities (August–

October 1936), Institute Activities (December 1936–June 1937, chairman), and Model Registration Law (1937–38).

J. V. L. Hogan (AM '11, F '54, Member for Life), president, Hogan Laboratories, Inc., New York, N. Y., and founder of station WQXR, New York, will be given the Institute of Radio Engineers (IRE) Medal of Honor at the IRE National Convention to be held in New York next March. This award was given "for his contributions to the electronics field as a founder and builder of IRE, for the long sequence of his inventions, and for his continuing activity in the development of devices and systems useful in the communications art." Mr. Hogan was laboratory assistant to **Lee de Forest** (AM '04, F '18, Member for Life) in 1906. From 1910 through 1921 he was with the National Electric Signaling Company and the International Radio Telegraph Company, after which he became a consulting engineer in New York City. He is responsible for many inventions in radio, television, and facsimile fields. He founded and owned the WQXR radio station until it was purchased by *The New York Times*. He was instrumental in the establishment of IRE, and served as vice-president (1916–19) and president (1920). He has been on the following AIEE Committees: Standards (1923–24, 1927–30, 1932–38), Communications, (1947–48), and Telegraph Systems (1949–55).

Hugh Odishaw (AM '45), consultant to the director, National Bureau of Standards, Washington, D. C., is executive secretary of the United States National Committee for the International Geophysical Year. He received both a bachelor of arts and master's degree from Northwestern University and a bachelor of science degree from Illinois Institute of Technology. He was an instructor of English and mathematics at Illinois Institute of Technology until 1943. Then he joined Westinghouse Electric Corporation's staff engaged in radar activities. He was a civilian attached to the Air Force and the Office of Scientific Research and Development. From 1946 through 1954 he was assistant to the director of the National Bureau of Standards. He is a member of the American Association for the Advancement of Science, the American Physical Society, the History of Science Society, and Phi Beta Kappa.

R. A. Ruscetta (AM '53), supervising chemist, capacitor development unit, transformer and allied products laboratory, General Electric Company, Pittsfield, Mass., has been appointed supervisor of manufacturing processes, Irmo, S. Carolina. The company is building a new capacitor plant at Irmo. Mr. Ruscetta, was educated in engineering and chemistry at Rensselaer Polytechnic Institute, joined the Pittsfield Works laboratory in 1926 as laboratory assistant, and progressed steadily to his new assignment. He has received eight U. S. patents for various developments in capacitors, and in 1949 received the Charles A. Coffin award for outstanding work in the origin, development, and application of a time-saving system for drying capacitors and transformers. He is a member of the American Chemical Society, the National Research Council, and the American Association for the Advancement of Science.

R. N. Youts (AM '45), system chief operator, Pennsylvania Water and Power Company, has joined The Connecticut Power Company as chief system operator, Connecticut Valley Power Exchange. This is a new position resulting from expansion of operations of the three interconnected transmissions systems of Connecticut Power, The Hartford Electric Light Company, and Western Massachusetts Electric Company.

R. K. Honoman (AM '16, F '36), special consultant and director, Office of Strategic Information, Washington, D. C., is now assistant secretary of defense for public affairs in the office of the assistant secretary for legislative and public affairs, Department of Defense. (See *Electrical Engineering*, January 1955, page 83, for Mr. Honoman's complete biography.)

B. J. Barmack (AM '20, M '27), senior engineer, Line Design Division, engineering department, Commonwealth Edison Company, Chicago, Ill., has received the American Society for Testing Materials' (ASTM) Award of Merit "for outstanding service to the ASTM in its technical committee work." He is a graduate of the University of Liege, Belgium, from which he received an electrical engineering degree in 1913. He joined the testing laboratory of the Philadelphia (Pa.) Electric Company in 1914, and became a member of the engineering department of Commonwealth in 1916. At Commonwealth he worked on designing materials and methods of construction for overhead and underground distribution plants. Mr. Barmack is a member of the American Standards Association, the National Electric Light Association, and the Western Society of Engineers.

C. H. Maddox (M '47), chief engineer, radio station KTBS, Shreveport, La., has been promoted to chief engineer for KTBS-TV, which was recently put into operation in Shreveport. Mr. Maddox has served as an instructor in the radio and electronics field on the faculty of Centenary College, Shreveport.

A. B. Smith (AM '04, F '22), vice-president, Automatic Electric Laboratories, Inc., Chicago, Ill., has retired after more than 40 years with the company. He was a research engineer, inventor, and communications pioneer, with 31 U. S. patents in the field of telephonic communications. Dr. Smith worked for various telephone companies in Nebraska, Iowa, and New York, before joining Automatic Electric.

H. A. Bergen (AM '51), senior associate editor, *Consulting Engineer* magazine; associate editor, *Industry and Power*, has been appointed editor of Industry and Power. He is a member of AIEE, Institute of Radio Engineers, National Society of Professional Engineers, Michigan Society of Professional Engineers, Western Society of Engineers, Eta Kappa Nu, Tau Beta Pi, and Pi Delta Epsilon. He is also a member of the AIEE Industrial Power Systems Committee (1954–55).

G. R. Fluehr (AM '41), secretary-treasurer, Kuhlman Electric Company, Bay City, Mich., has been elected president. Mr. Fluehr was born in Amboy, Ill., and attended the University of Wisconsin before entering the public utility sales promotion and electrical contracting fields. He joined the firm in 1935 as a director.

E. E. Moyer (M '44), engineer, International Business Machines Corporation, Poughkeepsie, N. Y., has joined Acme Electric Corporation, Cuba, N. Y. as director of research. He will direct the development of electronic devices in the company's expansion program. He has worked in the electrical and electronics industries where his contributions have resulted in the granting of more than 40 patents. Mr. Moyer is a graduate of Notre Dame University, South Bend, Ind. He also completed special subject postgraduate studies, University of the State of New York Technical Teacher Training, and was accredited to teach in the technical high schools of New York State. During World War II he was an instructor on electronics and controls, and served as assistant professor at Rensselaer Polytechnic Institute, New York. He has written many articles for engineering magazines, and has served on the AIEE Industrial Control Committee (1948–55).

L. E. Finzi (AM '40, M '49), professor of electrical engineering, Carnegie Institute of Technology, Pittsburgh, Pa., has been given a grant from the National Science Foundation in the amount of $15,000 for research in electrical machinery. The foundation has extended only three electrical engineering grants in the United States. Last year Dr. Finzi received the Carnegie teaching award. He is an authority on magnetic amplifiers, and electrical power and machinery. In 1946, he was in charge of the high-voltage impulse laboratory of the Westinghouse Electric Corporation, East Pittsburgh, Pa. He was educated in Europe and received a master's degree in electrical engineering from Naples University, Napoli, Italy, in 1926, and his doctorate from the Institute of Technology, Aacken, Germany, in 1932.

J. W. St. Andre (AM '43, M '48), public relations director, Anderson Nichols and Company, New York, N. Y., has become associated with Kaiser Aluminum and Chemical Corporation, Newark, Ohio, as chief electrical engineer. Previously, he was electrical editor for McGraw-Hill Publishing Company, New York, N. Y. From 1931 to 1935 he served in the Merchant Marine service. During World War II, he was electrical engineer and later became general superintendent for all maintenance for Wright Aeronautical Corporation, Woodridge, N. J. Later, he worked as corporation chief electrical engineer at General Cable Corporation, Perth Amboy, N. J. Mr. St. Andre has served on the AIEE Industrial Power Systems Committee (1953–54).

A. Malkin (AM '44, M '51), assistant to construction engineer, Canadian Car and Foundry Company, Ltd., Montreal, Quebec, Canada, recently established a partnership in Montreal—MacArthur, Malkin and Company, Consulting Engineers and Inspectors. He has been actively engaged in the design and supervision of electrical installations covering commercial, institutional, industrial, and plant projects and has served on committees on electrical problems with the AIEE and the Canadian Electrical Association.

Carl Beckman (AM '41), manager, research center electromechanisms department, Development Division, Burroughs Corporation, Paoli, Pa., has been appointed to the position of manager of the newly organized Automation and Process Control Division. He will direct the design and development of industrial automation equipment using digital computer techniques.

C. H. Bartlett (AM '52), manager, Manufacturing and Repair Division, Westinghouse Electric Corporation, and **C. C. Shutt** (AM'28, F'51), manager, Small Motor Division, Westinghouse Electric Corporation, have been elected vice-presidents of the company. Both joined the company as students in the graduate training program, Mr. Bartlett in 1928 and Mr. Shutt in 1926. Mr. Bartlett was graduated from the University of Colorado in 1928 with the degree of bachelor of science in electrical engineering. After training in sales, he joined the Transformer Division sales department and in 1944 was named manager of the instrument and specialty department sales. Later he was appointed manager of the transformer specialty department and in 1949 was named sales manager for the division. He was manager of the Transformer Division from 1952 until late 1953 when he attended the Harvard School for Advanced Management. He returned to the Transformer Division and early in 1954 was named manager of the Manufacturing and Repair Division, which services and builds Westinghouse equipment in its many plants located in principal industrial centers. Mr. Shutt was graduated from Iowa State College in 1926 with a bachelor of science degree in electrical engineering. After completing the student training program and design school, he became a section engineer in the Generator Division at East Pittsburgh, Pa. In 1938 Mr. Shutt was transferred to the Small Motor Division as manager of the engineering department and 2 years later was named manager of the division which, in addition to Lima, Ohio, has plants at Bellefontaine and Upper Sandusky, Ohio, and Union City, Ind. Mr. Shutt received his master's degree in electrical engineering at the University of Pittsburgh in 1933.

H. A. Jurgens (AM '47), assistant manager, International Business Machines (IBM) Corporation's laboratory at Endicott, N. Y., has been appointed manager of card engineering. In his new assignment, he will have over-all responsibility for all card engineering operations for the company. He will also co-ordinate production operations for all card manufacturing plants. He joined the company in 1937 as a student customer engineer in Endicott, and later was assigned to customer engineering duties in St. Louis, Mo., and in Caracas, Venezuela. In 1943 he became a customer engineering instructor in the IBM School in Endicott, and later that year was appointed a designer in development engineering. Subsequent appointments included project designer, assistant development engineer, and senior development engineer. In 1952 Mr. Jurgens was named assistant manager of the Endicott laboratory. A native of New Orleans, La., he holds a bachelor of science degree in electrical engineering from the Milwaukee School of Engineering. He has completed courses in the IBM School in engineering electronics, electronics design, pre-engineering mathematics, refresher mathematics, manager training, and engineering forum.

OBITUARIES....

Joseph Franklin Dix Hoge (AM '08, M '13), retired, died September 5 after a short illness. As an engineer, with the Bell Telephone Laboratories, he specialized in sound amplification systems and problems. Mr. Hoge was graduated from Cornell University in 1909. He joined the Bell Laboratories in 1918 and retired in 1946. During World War II, one of the projects he undertook was to aid the United States Navy in developing a battle announcing system for use on warships.

Harry Laurence Scott (M '49), owner and manager of the H. L. Scott Electrical Engineer and Construction Company, died recently. He was South Texas director of the National Electrical Contractors Association, a member of the South Texas Engineers Club, and many service organizations. Born in Vine Grove, Ky., June 26, 1894, he attended grade school in Kentucky, high school in Oklahoma, and college in Arkansas.

Roy R. Nissley (AM '41, M '54), switchgear specialist with Westinghouse Electric Corporation, died recently. From 1926 to the time of his death Mr. Nissley was associated with Westinghouse, starting in the position of industrial application engineer, and advancing through various departments to his last position of engineering manager of the New York engineering department. He taught evening courses in electrical distribution for industrial plants, application of power circuit breakers, and graduate study courses for Westinghouse in New York, N. Y., in conjunction with Stevens Institute, Polytechnic Institute, and New York University. During 1948–49, Mr. Nissley also conducted courses in industrial distribution for the educational committee of the New York Section of the AIEE. Upon receiving his degree in electrical engineering in 1925 from Pennsylvania State College, he took the graduate student course offered by Westinghouse Electric and Manufacturing Company in East Pittsburgh, Pa. He served on the following AIEE Committees: Industrial Power Systems (1951–55), and General Industry Applications (1952–54).

Gordon H. Finch, (AM '44) district manager Western District, Canadian Westinghouse District Apparatus Division, died recently at the age of 57. Born in Cookshire, Province of Quebec, Mr. Finch was a graduate of the University of Manitoba. In 1924 he enrolled in the graduate student training course at Westinghouse. He later engaged in apparatus sales work and filled various positions in Winnipeg, B. C., Calgary, Manitoba, and Ottawa Ont., before being transferred to Montreal in 1946. The following year Mr. Finch was named manager of the Westinghouse Apparatus Division's Quebec District and, in 1951, was transferred to Edmonton where he became sales manager for the district. In January of this year, he was appointed to Western District manager in Winnipeg. Gordon Finch was an active member of many organizations, among them the Engineering Institute of Canada, Canadian Electrical Association, Canadian Institute of Mines and Metallurgy, Association of Professional Engineers of Alberta, and Alberta and Northwest Chamber of Mines (director). He also belonged to the Edmonton Electric Club. He served throughout World War I with the Canadian Army.

E. Nathan Jolliff, midwest divisional manager Crouse-Hinds Company, Syracuse N. Y., died recently. A native of Shreveport, La., Mr. Jolliff began his 16 years of service with Crouse-Hinds as a field engineer in Houston, Tex. He transferred to Dallas in 1944, and became North Texas regional manager 2 years later. In 1952 he was appointed divisional manager of the newly created Midwest Division—North Texas, New Mexico, Colorado, Wyoming, and Oklahoma—with headquarters in Tulsa. Mr. Jolliff was executive secretary of the Petroleum Electric Supply Association. He was a past member of the Dallas Electric Club and the Engineers Club, and of the International Association of Electrical Inspectors and the Illuminating Engineering Society.

Charles B. Hayden (AM '15, M '32, Member for Life) died September 8, 1955, at the age of 83. He was born June 18, 1872 in Sun Prairie, Wis. He majored in electrical engineering at the University of Wisconsin, Madison, Wis., graduating in 1896. He was employed by the Madison Gas and Electric Company for a short period, then designed and built electrical distribution systems in a number of communities and rural areas. He joined the staff of the Railroad Commission of Wisconsin, now the Public Service Commission (PSC) in 1913 and retired in 1948. He was a member of many Wisconsin organizations, including the Technical Club of Madison. He was a registered professional engineer in Wisconsin. During the period with the PSC, he was a member of the National Electrical Safety Code Committee and the Code for Electricity Meters Committee. He did original work on the co-ordination of electrical and communi-

cation systems and on mitigation of electrolysis. He was a past president of the Conference of Utility Commission Engineers and served on a number of committees for that organization.

MEMBERSHIP • • •

Recommended for Transfer

The Board of Examiners at its meeting of September 15, 1955, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the Secretary of the Institute. A statement of valid reasons for such objections, signed by a member, must be furnished and will be treated as confidential.

To Grade of Member

Adams, C. T., president, Henry Adams, Inc., C. E., Baltimore, Md.

Allis, D. J., engineer, New England Power Service Co., Worcester, Mass.

Anderson, J. W., electrical engineer, U. S. Corps of Engineers, Portland, Oreg.

Anger, E. G., development engineer, Square-D Co., Milwaukee, Wis.

Anstey, J. E., staff member, Sandia Corp., Albuquerque, N.Mex.

Armstrong, J. A., plant engineer, Canadian Ohio Brass Co., Niagara Falls, Ont., Canada

Ashby, J. H., Jr., sponsor engineer, elec. utility sec., General Electric Co., Schenectady, N. Y.

Baker, H. L., public utilities specialist, U. S. Bureau of Reclamation, Billings, Mont.

Barmby, A. R., engineer, Sperry Gyroscope Co., Great Neck, N. Y.

Barnes, W. J., proprietor, Walter J. Barnes Electric Co., New Orleans, La.

Barta, R. L., electrical engineer, U. S. Dept. of Interior, Bureau of Reclamation, Billings, Mont.

Bate, B. R., supervising senior engineer, R. W. Beck & Assoc., Columbus, Nebr.

Behrens, C. C., chief engineer, The Ohio Bell Telephone Co., Cleveland, Ohio

Bibbs, J. C., branch manager, Westinghouse Electric Corp., Fort Worth, Tex.

Bigelow, J. E., supervising engineer, General Electric Co., Milwaukee, Wis.

Bonnyt, E. F., electric utility applicatiou engineer, General Electric Co., Portland, Oreg.

Brereton, D. S., application engineer, General Electric Co., Schenectady, N. Y.

Brightman, P. P., power systems engineer, General Electric Co., Schenectady, N. Y.

Broaddus, F. H., electrical engineer, D.P.W., U. S. Navy, San Bruno, Calif.

Browne, H. E., transmission engineer, The Ohio Bell Telephone Co., Dayton, Ohio

Burnell, H. L., Pacific region service supervisor, Allis-Chalmers Mfg. Co., San Francisco, Calif.

Caldwell, W. S., Jr., electrical engineer, Chas. T. Main, Inc., Boston, Mass.

Carson, R. M., consulting & application engineer, Westinghouse Electric Corp., San Francisco, Calif.

Catt, C. D., staff engineer, El Paso Natural Gas Co., El Paso, Tex.

Christensen, O. M., partner, Reynolds, Beach & Christensen, Seattle, Wash.

Courtney, F. M., development engineer, gyro systems, General Electric Co., Schenectady, N. Y.

Cushing, P., Jr., electrical engineer, Electrons, Inc., Newark, N. J.

Davis, L. G., president, Fisk Electric Co., Houston, Tex.

Davis, W. A., protection engineer, San Diego Gas & Electric Co., San Diego, Calif.

Dennis, K. R., secy-treas. & engineer, Northwest Electric Co., Seattle, Wash.

Detjen, E. R., engineer, Delaware Power & Light Co., Wilmington, Del.

Dunbar, G. R., switchgear engineer, Westinghouse Electric Corp., San Francisco, Calif.

Dusenbury, C., consulting & application electrical engineer, Westinghouse Electric Corp., Atlanta, Ga.

Eagan, W. F., engineer, Allis-Chalmers Mfg. Co., West Allis, Wis.

Earnheart, R. L., project engineer, U. S. Corps of Engineers, McNary Project Office, Oreg.

Elworthy, B. C., president & chief engineer, Elworthy & Co., Ltd., Vancouver, B. C., Canada

Engelfried, G. C., asst. design engineer, Gibbs & Hill, Inc., New York, N. Y.

Fargis, E. A., manager, Noland Co., Inc., Spartanburg, S. C.

Fisher, G. L., military products test engineer, AC Spark Plug Div., General Motors Corp., Flint, Mich.

Foster, S. L., engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Fowler, J. G., senior engineer, Southwestern Bell Telephone Co., Topeka, Kans.

Frazier, E., electrical engineer, C. F. Braun & Co., Alhambra, Calif.

Fuller, L. F., Jr., senior engineer, Bechtel Corp., San Francisco, Calif.

Gaumond, P. C., supervisory engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.

Gauper, H. A., Jr., engineer, General Electric Co., Schenectady, N. Y.

Glover, E. C., assoc. professor, San Jose State College, San Jose, Calif.

Goetz, E. A., asst. chief engineer, research & dev. sec., Arma Corp., Garden City, N. Y.

Grimm, C. J., asst. professor of electrical engg., Missouri School of Mines & Metallurgy, Rolla, Mo.

Guerrieri, J. A., electrical group engineer, Northrop Aircraft, Inc., Hawthorne, Calif.

Hammond, H. G., engineer, The Detroit Edison Co., Detroit, Mich.

Hargreaves, P. F., engineer, Puget Sound Power & Light Co., Seattle, Wash.

Hickenlooper, F. T., electrical engineer, Columbia-Geneva Steel Div., U. S. Steel Corp., Provo, Utah

Hickman, G. K., transmission engineer, Wisconsin Electric Power Co., Milwaukee, Wis.

Howard, J. D., Jr., engineer, American Tel. & Tel. Co., 195 Broadway, New York, N. Y.

Hulbert, F. L., product designer, Square-D Co., Cedar Rapids, Iowa

Humphrey, J. T., field engineer, Westinghouse Electric Corp., San Diego, Calif.

Hunsinger, G. O., engineer of wires & cables, Western Insulated Wire Co., Los Angeles, Calif.

Ingraham, C. W., sales engineer, Sangamo Electric Co., Dallas, Tex.

Johnston, A. T., consulting engineer, Union Switch & Signal Div., Westinghouse Air Brake Co., Pittsburgh, Pa.

Kaehler, E. M., electrical engineer, U. S. Bureau of Reclamation, Sacramento, Calif.

Kambouris, G. N., electrical engineer, Diamond Ordnance Fuze Labs., Washington, D. C.

Kellogg, D. S., engg. dept. head, General Precision Laboratory, Inc., Pleasantville, N. Y.

Kiefer, J. F., supt., transmission & distribution dept., Delaware Power & Light Co., Wilmington, Del.

Knieriemen, E. L., chief engineer, DuBois Engg. & Mfg. Corp., Hammond, Ind.

Kremski, E. S., section engineer, The Louis Allis Co., Milwaukee, Wis.

Lambert, R. H., electrical design & development engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Lee, C. B., consulting engineer, John Oster Mfg. Co., Racine, Wis.

Lee, J. L., communications manager, Gulf, Colorado & Santa Fe Railway Co., Galveston, Tex.

Lovallo, D. A., design engineer, General Electric Co., Pittsfield, Mass.

Lyall, R. M., manager, electric utility sales, General Electric Co., Milwaukee, Wis.

MacNeil, C. F., manager, agency & resale, Canadian Westinghouse Co., Montreal, Que., Canada

Margolin, H. B., engineer, American Gas & Electric Service Corp., New York, N. Y.

Marshall, J. C., substation inspector, PUD of Clark County, Vancouver, Wash.

Meyer, H., asst. to manager of electrical engg., Brown Boveri Co., Ltd., Baden, Switzerland

Michell, R. G., electrical engineer, Allis-Chalmers Mfg. Co., Boston, Mass.

Miller, W. J., development engineer, General Electric Co., West Lynn, Mass.

Minder, P. M., application engineer, Line Material Co., South Milwaukee, Wis.

Moon, G. F., electrical engineer, U. S. Dept. of Agriculture, Rural Electrification Administration, Washington, D. C.

Nielsen, C. E., electrical division chief, Ebasco Services, Inc., New York, N. Y.

Nowakowski, R. S., development engineer, The Louis Allis Co., Milwaukee, Wis.

O'Connor, R. A., electrical engineer, Reynolds Electrical & Engineering Co., Inc., El Paso, Tex.

O'Donnell, D. J., section head, Motor & Transformer Engg. Dept., Sperry Gyroscope Co., Great Neck, N. Y.

Oldenkamp, J. L., development engineer, General Electric Co., Fort Wayne, Ind.

Oman, N. W., owner-manager, Oman Supply Co., Rockford, Ill.

Oriel, C. W., sponsor engineer, Ebasco International Corp., New York, N. Y.

Ownbey, E. H., supervisor, radio engg. section, Tennessee Valley Authority, Chattanooga, Tenn.

Pearson, H. F., standards engineer, Portland General Electric Co., Portland, Oreg.

Pennoyer, D. H., member of technical staff, Bell Telephone Labs., New York, N. Y.

Rivington, N. G. C., electrical engineer, Montreal Engineering Co., Ltd., Montreal, Que., Canada

Robinson, L., texas plant supervisor, Mountain States Tel. & Tel. Co., El Paso, Tex.

Roller, M. P., electrical engineer, production dept., Iowa-Illinois Gas & Electric Co., Davenport, Iowa

Rose, C. L., electrical engineer, U. S. Bureau of Reclamation, Denver, Colo.

Ross, H. C., electrical engineer, Jennings Radio Mfg. Corp., San Jose, Calif.

Roszcki, W., asst. chief technical sales engineer, Bruce Peebles & Co., Ltd., Edinburgh, Scotland

Scanlan, J. P., staff engineer, Mutual Boiler & Machinery Insurance Co., Montclair, N. J.

Schaudenecker, A. F., equipment engineer, Western Electric Co., Chicago, Ill.

Schultz, B. H., product section engineer, Line Material Co., South Milwaukee, Wis.

Shinkle, R. W., protection engineer, Kansas City Power & Light Co., Kansas City, Mo.

Simson, V. H., electrical engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

Slade, L. E., vice pres. & secretary, Iowa Power & Light Co., Des Moines, Iowa

Smith, F. A., transmission & protection engineer, New England Tel. & Tel. Co., Portland, Maine

Smith, R. W., electrical engineer, Montreal Engineering Co., Ltd., Montreal, Que., Canada

Spalding, D. A., retired, 29 Road RR 1, Haney, B. C., Canada

Stephens, D. H., supervisor, electrical group, Northrop Aircraft Inc., Hawthorne, Calif.

Stetler, J. S., division engineer, Pennsylvania Power & Light Co., Hazleton, Pa.

Stouch, C. R., manager, user sales, General Electric Co., Charleston, W. Va.

Underwood, M. R., meter engineer, Indianapolis Power & Light Co., Indianapolis, Ind.

Usher, T. E., supervisor design engineer, General Electric Co., West Lynn, Mass.

Vanora, J. A., production section engineer, The M. W. Kellogg Co., New York, N. Y.

Venkatesan, N., deputy director (power wing), Central Water & Power Comm., New Delhi, India

Vinze, S. N., deputy director, Central Water & Power Commission, New Delhi, India

Vrooman, C. R., asst. manager, Industrial Products Engg., Canadian Westinghouse Co., Hamilton, Ont., Canada

Walley, O. C., technical advisor, Jack & Heintz, Inc., Cleveland, Ohio

Walls, H. M., asst. division engineer, Southwestern Gas & Electric Co., Longview, Tex.

Waters, W. F., senior engineer, Southwestern Bell Telephone Co., Dallas, Tex.

Watkins, L. D., electrical engineer, Southwestern Public Service Co., Amherst, Tex.

Wells, J. A., application engineer, Westinghouse Electric Corp., Sunnyvale, Calif.

Williams, N. E., senior electrical design engineer, Brush Electrical Engineering Co., Ltd., Cardiff, Wales, Great Britain

Woodall, T. H., senior engineer, Arizona Public Service Co., Phoenix, Ariz.

119 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member, have been received from the following candidates, and any member objecting to election should supply a signed statement to the Secretary before November 25, 1955, or January 25, 1956, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Atton, A. M., Vickers-Armstrongs Aircraft Ltd., Weybridge, Surrey, England

Barrows, W. I., New England Power Service Co., Northampton, Mass.

Burlingame, L. G., Lenkurt Electric Co., San Carlos, Calif.

Dement, A. M., General Electric Co., Pittsfield, Mass.

Dublin, M., U. S. Air Forces in Europe, APO 633, New York, N. Y.

Fagan, M. T., Pennsylvania Power & Light Co., Hazleton, Pa.

Fletcher, C. N., Edward G. Herbert Ltd., Manchester, England.

Flood, J. H., J. H. Flood & Co., Waco, Tex.

Frey, R. C., Pacific Tel. & Tel. Co., San Francisco, Calif.

Gag, J. B., Electric Specialty Co., Stamford, Conn.

Harrison, A. E., The Pacific Tel. & Tel. Co., Los Angeles, Calif.

Iyengar, B. R. R., Hyderabad State Electricity Dept., Hyderabad, Deccan, India

Kellerman, L. B., Victor Equipment Co., Los Angeles, Calif.

King, S. Y., University of Hongkong, Hongkong

Kinnon, W. C., Allis-Chalmers Mfg. Co., Phoenix, Ariz.

Lee, P. H., Intelec, Caracas, Venezuela, S.A.

Lindsey, H. P., Arkansas Power & Light Co., Little Rock, Ark.

Lloyd-Jones, I. R., East Midlands Electricity Board Engineering Group, C.E.A., Ilkeston, Near Nottingham, England

McGuigan, W. D., Stanford Research Institute, Stanford, Calif.

McNeill, C. A., A. R. Wade Ltd., Alderahot, England

Marvin, P. R. (re-election), American Viscose Corp., Philadelphia, Pa.

Mowry, V. E., Stackpole Carbon Co., St. Marys, Pa.

Murphy, E. J., Ottawa Hydro-Elec. Comm., Ottawa, Ont., Canada

Naylor, J. H., Central Electricity Authority, London, England

O'Neil, J. A., Metropolitan Transit Authority, Boston, Mass.

Porter, H. M., Westinghouse Electric Corp., Chicago, Ill.

Radke, S. F., Reynolds Metals Co., Richmond, Va.

Robbins, C. M., Sr., Philco Corp., Hqrs. Continental Air Defense Command, Colorado Springs, Colo.

Safarik, E. R., Leich Electric Co., Genoa, Ill.

Scuderi, K. J., Youngstown Sheet & Tube Co., East Chicago, Ind.

Shaw-Yates, G. P. B., DeHavilland Aircraft Co., Ltd., Hatfield, Herts, England

Sheikh, R. A., Public Works Dept., Electricity Branch, Lahore, Pakistan

Timm, L. J., Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. Co., Irvington, N. J.

Weldon, J. O., Continental Electronics Mfg. Co., Dallas, Tex.

Zenner, W. J., Teletype Corp., Chicago, Ill.

35 to grade of Member

AIEE Section and Student Branch Meetings

1954-55

Table I. Section Membership, August 1955; Section Meetings During Year Ending April 30, 1955

Section	AIEE Members August 1955	Number of Meetings	Total Number of Meetings
Akron	220	9	9
Alabama	318	10	10
Arizona	272	9	
Group: Technical		19	28
Arkansas	162	10	
Group: Power Distribution		2	
Subsection: Northwest Arkansas		9	21
Arrowhead	84	8	8
Baton Rouge	71	4	4
Beaumont	120	13	
Subsection: Lake Charles		8	21
Boston	1,078	7	
Groups: Basic Sciences		2	
Communications		2	
Electronics		2	
Industrial Power Applications		1	
Instruments and Measurements		2	
Insulation		2	
Power Distribution		2	
Power Generation		2	
Power Transmission		2	
Transportation		2	26
Canton	131	8	
Groups: Management Discussion		3	
Power Discussion		3	14
Central Illinois	212	9	
Group: Technical		5	14
Central Indiana	383	9	9
Chicago	2,231	5	
Groups: Basic Sciences		3	
Communications		4	
Electronics		5	
Industrial		5	
Power		5	27
Cincinnati	386	12	12
Cleveland	1,052	10	
Groups: Basic Science		5	
Electrical Construction		5	
Electronics, Communication and Instrumentation		4	
Management Discussion		5	
Motors and Controls		4	
Power Generation and Distribution		5	38
Columbus	289	12	
Subsection: Chillicothe		8	
Zanesville		11	31
Connecticut	791	8	
Group: Technical		17	25
Corpus Christi	111	12	
Group: Electrochemical		1	13
Dayton	348	6	
Groups: Aeronautics		3	
Electronics		3	
Motors and Control		2	
Power		2	
Subsection: Lima		1	
Joint Meetings: Section and Power Group		1	
Section and Motors and Control Group		1	
Section and Electronics Group		1	20
Delaware Bay	168	12	
Group: Discussion		2	14
Denver	444	9	
Groups: Communications and Electronics		4	
Equipment		4	
Power Systems		5	
Subsection: Black Hills		5	
Southern Colorado		3	
Joint Meetings: Denver Section and Communications and Electronics		1	31
East Tennessee	408	18	
Groups: Chattanooga Technical		8	
Knoxville Technical		5	
Subsections: Huntsville		11	
Muscle Shoals		7	
Tullahoma		8	57
El Paso	140	12	12
Erie	191	16	16
Fort Wayne	218	9	9
Georgia	342	9	
Subsection: Savannah		2	11
Hamilton	212	11	
Subsection: London		6	17
Hawaiian	93	10	10
Houston	371	9	
Groups: Industrial Applications		7	
Power		2	
Wire Communications		1	
Subsection: Freeport		9	28
Illinois Valley	86	12	
Group: Technical		9	21
Iowa	192	10	
Subsection: Northwest Iowa		2	
Quad-Cities		1	13
Iowa-Illinois	86	7	7
Ithaca	379	8	
Group: Technical Discussion		5	
Subsections: Binghamton Area		7	
Binghamton Area Discussion Group		3	23
Jacksonville	104	9	9
Kansas City	425	12	
Groups: Communications		4	
Petroleum		2	
Power		4	
Joint Meetings: Section and Petroleum and Communications		1	
Section and Petroleum and Power		1	24
Lehigh Valley	471	10	
Group: Technical Discussion		21	31
Lima	100	8	
Groups: Aeronautics Discussion		3	
Motors and Control Discussion		2	13
Los Angeles	2,362	8	
Groups: Aircraft		5	
Communications		4	
Electronics		6	
Management		2	
Power		7	
Young Engineers Council Division		5	
Subsections: Boulder City		9	
Riverside-San Bernardino		6	
Joint Meetings: Los Angeles Section and Aircraft Electronics		1	53
Louisville	244	10	
Subsections: Lexington		5	
Paducah		8	23
Lynn	338	25	
Subsection: Maine		4	29
Madison	118	10	10
Mansfield	123	8	8
Maryland	900	9	
Groups: Aircraft		5	
Communications		2	
Industrial Electronics		3	
Power		3	
Subsection: Eastern Shore		8	30
Memphis	124	10	10
Mexico	190	12	12
Miami	188	12	12
Michigan	1,093	8	
Groups: Communications		3	
Education		2	
Industry		2	
Management		3	
Power		4	
Science and Electronics		4	
Subsection: West Michigan		1	27
Milwaukee	971	7	7
Groups: Basic Sciences		1	
Electric Machinery		3	
Electronics Discussion		3	
Power Application and Control Discussion		4	
Transmission and Distribution		4	
Subsections: Fox River Valley		8	
Racine-Kenosha		7	37
Minnesota	472	11	
Subsection: Red River Valley		8	19
Mississippi	98	7	7
Mobile-Pensacola	121	10	10
Montana	123	3	
Subsection: Billings		6	
Great Falls		2	11
Montreal	490	12	12
Nashville	105	8	8
Nebraska	229	12	
Group: Technical		8	20
New Hampshire	134	6	6
New Orleans	247	8	
Subsection: Baton Rouge		6	14
New York	5,983	3	
Groups: Basic Science		2	
Communication		8	
Illumination		5	
Power and Industrial		15	
Transportation		6	
Subsections: Hudson Valley		4	
New Jersey		12	
Joint Meetings: New Jersey and Basic Science Divisions		1	
Communication and Transportation Divisions		1	57
Niagara Frontier	380	8	8
Niagara International	162	15	15
North Carolina	432	2	
Subsections: Charlotte		7	
Eastern North Carolina		6	
Mid-State		8	
Western North Carolina		9	32
Northeastern Michigan	142	12	12
Northern New Mexico	211	18	
Subsection: Los Alamos-Santa Fe		3	21
North Texas	679	7	
Groups: Aircraft Electric		5	
Communications		2	
Distribution Practices		2	
Electronics		2	
Industrial Practices		1	
Subsections: Central Texas		9	
Fort Worth		5	
West Central Texas		9	
Joint Meetings: Section and Fort Worth Subsection		2	4
Oak Ridge	91	10	
Group: Technical		1	1
Ohio Valley	106	13	
Subsection: Scioto Valley		4	17
Oklahoma City	217	9	
Groups: Communications		8	
Electronics		6	
Industrial Practices		5	
Power Systems		8	36
Ottawa	96	13	13
Panhandle Plains	168	9	
Group: Technical		9	18
Philadelphia	2,037	8	
Groups: Aircraft Electrical Systems		3	
Basic Sciences		3	
Communications		3	
Computer		2	
Electronics		3	
Industrial Practices		4	
Instruments and Measurements		3	
Power Systems		3	
Subsection: Atlantic City		6	
Joint Meetings: Section and Electronics Group		1	
Basic Science and Electronics Group		1	
Section and Communications Discussion Group		1	41

Section	AIEE Members August 1955	Number of Meetings	Total Number of Meetings
Pittsburgh	1,407	8	
Groups: Communications		3	
Industry		3	
Power Generation		2	
Science and Electronics		4	
Transmission and Distribution		4	
Subsections: Centre County		6	
Johnstown		3	33
Pittsfield	373	19	
Subsection: Vermont		4	23
Portland	552	19	
Subsection: Medford		6	25
Providence	212	12	
Group: Electronics		3	15
Richland	129	14	14
Ridgway	67	11	11
Rochester	269	19	19
Rock River Valley	134	10	10
Sacramento	138	11	
Group: Power Technical		3	14
St. Louis	770	10	
Groups: Industrial Apparatus		9	
Power Practices		8	
Subsection: Eastern Division		7	34
St. Maurice	52	8	8
San Diego	206	11	
Groups: Aviation Technical		6	
Industry		6	
Utility Technical		4	27
San Francisco	1,455	35	
Subsections: Fresno		8	
Honolulu		2	
Reno		8	
San Jose		8	
Shasta		7	68
Savannah	52	7	7
Schenectady	1,127	20	
Subsection: Adirondack		5	25
Seattle	801	11	
Groups: Aircraft		5	
Basic Sciences and Electronics		3	
Power		4	
Transportation		1	
Subsection: Tacoma		9	33
Sharon	252	8	8
Shreveport	153	10	
Subsection: Monroe		9	19
South Bend	134	10	10
South Carolina	241	1	
Subsections: Central Savannah River		5	
Charleston		10	
Columbia		10	
Piedmont		8	34
South Texas	152	11	11
Spokane	179	13	
Subsection: Wenatchee		10	23
Springfield	133	9	
Group: Technical		4	13
Susquehanna	140	6	6
Syracuse	421	9	
Subsection: St. Lawrence International		6	15
Tampa	189		
Toledo	188	11	
Groups: Joint AIEE-ASME Management		5	
Industry Practice Technical		2	
Power Technical		2	20
Toronto	742	14	
Groups: Communications		2	
Discussion		10	
Joint Meetings: Section and Discussion Group		1	
Section and Communications Group		1	28
Tulsa	229	9	
Group: Technical Session		14	23
Utah	174	4	
Subsection: Eastern Idaho		7	11
Vancouver	314	10	
Group: Discussion		8	
Subsection: Vancouver Island		10	28
Virginia	305	3	
Subsections: Hampton Roads		7	
Richmond		7	17
Virginia Mountain	114	6	6
Washington	1,077	10	
Groups: Basic Sciences		1	
Communications - Instrumentation-Electronics		2	
Nucleonics		2	
Power		2	17
West Michigan	97	7	7
West Virginia	127	10	
Groups: Electronics		3	
Power Distribution		3	16
Wichita	139	9	9
Worcester	132	8	8
	45,599		2,054

Total Sections, 107
Total Technical groups, 125
Total Subsections, 64

Table II. Branch Meetings Held During Year Ending April 30, 1955

Branch	Number of Meetings
*Akron, University of	3
Alabama Polytechnic Institute	6
Alabama, University of	13
*Alberta, University of	
*Arizona, University of	6
*Arkansas, University of	4
*British Columbia, University of	19
Brooklyn, Polytechnic Institute of	
* Day Division	10
* Evening Division	8
*Brown University	
*Bucknell University	7
*California Institute of Technology	1
*California, University of	15
*Carnegie Institute of Technology	8
Case Institute of Technology	4
Catholic University of America	2
*Cincinnati, University of	2
Clarkson College of Technology	6
Clemson A & M College	13
*Colorado A & M College	12
*Colorado, University of	8
*Columbia, University of	2
*Connecticut, University of	8
*Cooper Union	4
*Cornell, University of	6
*Dayton, University of	7
*Delaware, University of	7
*Denver, University of	9
*Detroit, University of	6
*Drexel Institute of Technology	8
Duke University	7
Fenn College	5
*Florida, University of	8
*George Washington University	2
Georgia Institute of Technology	4
Howard University	7
Idaho, University of	20
Illinois Institute of Technology	11
*Illinois, University of	7
Chicago Division	6
*Iowa State College	13
Iowa, University of	23
*Johns Hopkins University	18
Kansas State College	16
*Kansas, University of	7
Kentucky, University of	7
*Lafayette College	9
Laval University	
Lehigh University	7
Louisiana Polytechnic Institute	14
*Louisiana State University	10
* Louisville, University of	8
*Maine, University of	10
*Manhattan College	8
*Marquette University	9
*Maryland, University of	1
*Massachusetts Institute of Technology	7
*Massachusetts, University of	7
*Michigan College of Mining and Technology	14
*Michigan State College	13
*Michigan, University of	3
Milwaukee School of Engineering	10
*Minnesota, University of	12
Mississippi State College	13
*Missouri School of Mines and Metallurgy	11
*Missouri, University of	5
*Montana State College	9
*Nebraska, University of	12
Nevada, University of	13
Newark College of Engineering	11
*New Hampshire, University of	9
*New Mexico College of A & M Arts	6
*New Mexico, University of	2
*New York, College of the City of	20
New York University	
* Day Division	19
* Evening Division	5
*North Carolina State College	11
*North Dakota State College	6
*North Dakota, University of	8
*Northeastern University	14
*Northwestern University	20
Norwich University	3
*Notre Dame, University of	9
Ohio Northern University	8
*Ohio State University	1
*Ohio University	10
*Oklahoma A & M College	10
*Oklahoma, University of	4
Oregon State College	6
*Pennsylvania State College	14
*Pennsylvania, University of	10
Pittsburgh, University of	16
*Pratt Institute	13
*Princeton University	
Puerto Rico, University of	3
*Purdue University	7
*Rensselaer Polytechnic Institute	5
*Rhode Island, University of	2
Rice Institute	6
Rose Polytechnic Institute	5
*Rutgers University	7
Saint Louis University	4
Santa Clara, University of	4
*South Carolina, University of	15
South Dakota School of Mines and Technology	12
South Dakota State College	14
*Southern California, University of	19
*Southern Methodist University	2
*Stanford University	2
*Stevens Institute of Technology	3
Swarthmore College	4
*Syracuse University	7
Tennessee, University of	2
*Texas A & M College	6
*Texas Technological College	7
*Texas, University of	2
Texas Western College Sub-Branch	5
*Toledo, University of	10
*Toronto, University of	10
*Tufts College	7
*Tulane University	6
Union College	4
United States Naval Academy	4
*Utah, University of	18
Vanderbilt University	14
*Vermont, University of	5
*Villanova College	14
Virginia Military Institute	10
*Virginia Polytechnic Institute	15
*Virginia, University of	7
Washington, State College of	8
*Washington, University of	20
*Washington University	8
*Wayne University	8
*West Virginia University	4
*Wisconsin, University of	7
*Worcester Polytechnic Institute	7
*Wyoming, University of	14
*Yale University	6
	1,154

TOTAL BRANCHES 135
*Joint AIEE-IRE Branches (97)

OF CURRENT INTEREST

Closed-Circuit Television Proves Effective in Underwater Research

AN UNDERWATER APPLICATION of closed-circuit television, which is enabling the U. S. Fish and Wildlife Service, Department of the Interior, to observe and test the performance of experimental fishery methods and equipment under actual oceanic conditions, was reported recently by Theodore A. Smith, vice-president and general manager of the engineering products division, Radio Corporation of America (RCA). The application represents the first practical demonstration in the United States of underwater television as a research tool for experimental work in fishery operations, and gives promise of a wide range of uses in marine biology and explorations.

Currently, the Service is utilizing closed-circuit television in connection with the development of a midwater trawling net and in a remote study of shrimp in their natural habitat.

The Service's underwater television experiments were initiated with "Operation Fish-eye" conducted recently in the Gulf Stream off the east Florida coast. A standard RCA *ITV* closed-circuit television system provided remote observations of experimental fishery gear towed at depths of more than 60 feet. The gear was illuminated only by natural sunlight, and the views produced on the television monitor were sufficiently clear and sharp for photographing by both still and motion-picture cameras.

Research in the field of fishery methods and equipment has been hampered by the limited access to direct observations of fishing gear in operation. Advances in the design and construction of nets, trawls, and other devices have resulted largely from trial and error, scanty information obtained from work with models, or information supplied by divers working with underwater film cameras. The advent of underwater television research in other fields, indicating the possibilities of closed-circuit television as a means for securing direct observation of fishing gear and methods, led to the assignment of the project to the Service's Exploratory and Gear Development Station at Coral Gables, Fla.

In underwater operations, the *ITV* camera is housed within a watertight steel cylinder, devised by technicians of the Fish and Wildlife Service, which is mounted in a submersible free-flooded, ball-type "diving bell." (See front cover picture.) Atop the diving bell, and connected to it by a gear train and yoke assembly, is a watertight electrically driven power unit, which permits remote control of the television camera's scan: 360 degrees in azimuth and 90 degrees in elevation. What the television camera "sees" is projected over a flexible multiconductor cable to a remote-control monitor aboard the Service's research vessel, the USS *Pompano*.

It is conceivable that these systems can be operated at much greater depths than a diver can withstand and for much longer periods of time without the risk attendant to a diver operating an ordinary underwater film camera. Mr. R. F. Sand, chief of the Service's Gear Research and Development Program, pointed out the value of underwater television as an aid to investigations in marine biology and in limnology. He also predicted that in addition to gear research in the commercial fisheries, underwater television may also prove to be of assistance in the delineation and harvesting of clam, oyster, and scallop beds. It might be possible to obtain closer views of bottom formations, bottom-type fishes, and fishes in their natural habitat, which at present may be located only with difficulty by depth-sounding equipment. Further, underwater television offers possibilities of direct monitoring of water temperatures, current flows, turbidity, and other oceanographic data related to the fisheries.

Future Meetings of Other Societies

Association for Applied Solar Energy and the University of Arizona, World Symposium on Applied Solar Energy. November 1–5, Westward Ho Hotel, Phoenix, Ariz.

National Electrical Contractors Association, Annual Convention. November 2–5 ,Waldorf-Astoria Hotel, New York, N. Y.

Industrial Management Society, 19th Annual Time and Motion Study and Management Clinic. November 9–11, Sherman Hotel, Chicago, Ill.

The American Society of Mechanical Engineers, Diamond Jubilee Annual Meeting, November 13–18, Congress, Hilton, and Blackstone Hotels, Chicago, Ill. **Chicago Exposition of Power and Mechanical Engineering.** November 14–18, Chicago Coliseum.

National Electrical Manufacturers Association, Annual Meeting. November 14–18, Traymore Hotel, Atlantic City, N. J.

Armed Forces Chemical Association, Electronic Computer Symposium in conjunction with Second International Automation Exposition. November 14–17, Chicago Navy Pier, Ill.

Steel Founder's Society of America, 10th Annual Technical and Operating Conference. November 16–18, Hotel Carter, Cleveland, Ohio.

Air-Conditioning and Refrigeration Institute, 9th Exposition, November 28–December 1, Convention Hall, Atlantic City, N. J.

American Society of Refrigerating Engineers, Annual Meeting. December 1–3, Traymore Hotel, Atlantic City, N. J.

Aluminum Strips Reduce Size of Transformer Windings

A NEW DEVELOPMENT in the winding of electromagnetic coils for use in transformers, solenoids, and some motors and generators is expected to reduce the cost of coils substantially. The method involves winding coils with strips of aluminum foil or thin aluminum sheet instead of with conventional electric wire.

The construction and testing of coils wound in this manner was announced by Reynolds Metals Company, Louisville, Ky. The spiral winding of coils with aluminum utilizes anodic coatings for aluminum which serve as insulation for the strips of metal wound into a coil replacing the paper, glass, or enamel insulation normally used with wire coils. The methods and materials employed permit the production of light-weight, compact coils capable of operating at high temperatures with good heat dissipation features.

In most equipment where the space factor is important, this development makes possible the use of aluminum as a magnet conductor with no increase in equipment size. Spiral winding of the coils subjects the conductor insulation to turn voltage only and, accordingly, normal layer insulation can be eliminated. This saving in space, coupled with that derived from the use of the very thin anodic films for insulation and the lack of voids in the completed windings, accounts for the compactness of the coils. Further space savings are afforded by the

PARTIALLY COMPLETED solenoid coil using bare aluminum foil and polyester film insulation.

good heat-transfer characteristics of the coils. Since every turn of the coil is exposed to the outside, no hot spots are encountered and cooling ducts can be eliminated. Fins may be incorporated in the coils without materially increasing their size to provide additional cooling if desired.

The anodic coating, consisting of aluminum oxide—a chemically inert material and an excellent electric insulator—reduces the possibility of a coil's "burning out," since the melting point of the anodic coating is higher than that of aluminum.

Appreciable weight savings also are afforded by the new aluminum coils. In most cases, the coil weight is approximately one-half that of a comparable copper unit.

The winding process readily lends itself to mechanization and resultant low-cost production methods.

A recent development, the use of more conventional insulating materials such as polyester films in the new aluminum coil, offers additional advantages in many electrical applications.

LARGE COIL wound with anodized aluminum strip conductor is for 10-kva transformer. Small contactor coils are wound with bare aluminum foil and polyester film insulation. The new aluminum coils are capable of operating at high temperatures with good heat dissipation features.

New Test Equipment Detects Hidden Flaws in Electric Cable

DEFECTS, including tiny voids or bubble-like imperfections smaller than a grain of sand, in the rubber insulation on high-voltage cables can be identified and located readily by new nondestructive testing equipment developed by research engineers of The Okonite Company, Passaic, N. J.

Experience has shown that the inspection and test methods used for low-voltage wires and cables with relatively thin wall thicknesses of rubber insulation are inadequate for detecting flaws in high-voltage cables. For example, a proper high-voltage spark test will break down imperfections in low-voltage insulated conductors, but it is not practical to apply a high enough spark test voltage to find some types of defects in the insulation on higher voltage cables. Extra-high voltage, 60-cycle, and d-c tests made on the entire length of reel of high-voltage insulated conductors immersed in water are helpful in identifying the quality of cables, but it has been ascertained that even these tests are not the complete solution to the problem.

The new test equipment is useful in detecting and locating imperfections that are not revealed by other methods. It consists of three separate units or instruments arranged in series. The cable, after vulcanization of the rubber insulation, can be passed through all three units and examined continuously in one operation as it unwinds from a reel and is rewound on another.

The strip insulating process eliminates eccentric insulation which is so often a problem with heavy thicknesses of rubber insulation. However, there still remains the possibility of thin places in the insulation, such as at a dent, or other types of damage that might occur during manufacture. A place where the thickness of insulation is less than required may be a cause of breakdown or failure of the cable in service. The insulation thickness gauge, which is the first unit in the test equipment, is an electronic device which continuously records whether the thickness is correct and uniform throughout the entire length as the cable passes through it. Thin places are detected readily and exactly located.

During World War II, The Okonite Company designed, developed, and produced pulse-type cables for radar use. Freedom from ionization under operating conditions is an essential characteristic of pulse cables. The cables are tested for ionization by determining the minimum voltage at which discharge is present. This voltage has become known as the corona level. The test on pulse cables is made on samples.

Research engineers realized the possibilities of such testing as a supplement to tests that were made on rubber-insulated cables, particularly for higher voltage use. It was evident that tests on samples were not enough, since it was important that the entire length of each cable be free from the kinds of imperfections that cause ionization. Corona-level testing of full lengths of cable on reels, as used by many manufacturers, was found to be inadequate, as this method did not locate the places in a cable where ionization occurred. Also, there was a dampening effect on ionization when the test was made on long lengths of cables on reels, obscuring the true corona-level voltage of the weakest spot. In other words, it was almost impossible to identify a single void or other imperfection in a long length of cable when using the full-reel length corona-level test.

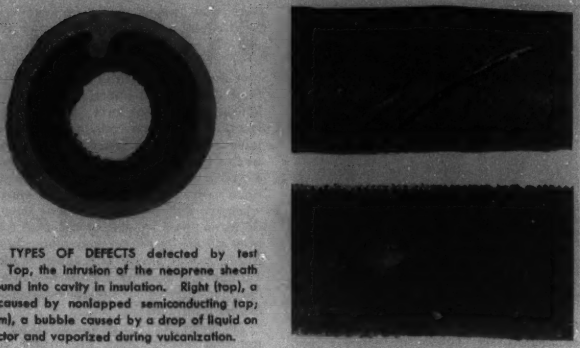
The need for a continuous corona-level test that would detect and locate defects throughout the length of cable became obvious. The equipment required for making such a test was not available. The design and development of the equipment turned out to be an involved task. After much research work, a new ionization or corona-measuring instrument was developed which would determine the exact location and magnitude of each imperfection that could cause ionization or low-corona level. This is the second unit in the test equipment.

The length of cable under test is run through the corona-level tester as it comes from the insulation thickness gauge. The insulated conductor is subjected to a voltage of at least one and one-half times the specified operating voltage as it passes through the test apparatus. The location of defects causing ionization is shown on a continuous recorder, which includes a footage marker.

The test equipment has proved to be dependable, and it detects defects in heavy thicknesses of insulation which there was no means of finding in the past. It is now possible to locate, and thus eliminate, defects that can lead eventually to failure in service, even though several years might elapse before trouble develops.

The third and last piece of test equipment is a 250,000-volt X-ray machine. It is used to determine the nature of the flaws indicated by the thickness gauge and ionization

OVER-ALL VIEW of the Gooding test train for cable testing. On the left is the capstan for drawing cable off reel. It passes through the equipment on top of the console where its insulation uniformity is checked, and its corona level is measured in the long insulating tube. Out of sight on the right-hand end is the 250-kv X-ray machine.



THREE TYPES OF DEFECTS detected by test train. Top, the intrusion of the neoprene sheath compound into cavity in insulation. Right (top), a void caused by nonlapped semiconducting tap; (bottom), a bubble caused by a drop of liquid on conductor and vaporized during vulcanization.

test units. Such serious faults as broken or damaged conductor strands, improperly applied Semicon tape under the insulation, and foreign matter in the insulation which may not be found by other methods, can be located and identified easily by fluoroscopic examination.

All rubber-insulated cable manufactured by The Okonite Company for operation above 4,000 volts is tested in the manner described. After the cable has been run through the test train the defects, if any, are repaired before it is immersed in water for the high voltage tests. If the nature of the imperfections, or their number, should be serious, the entire length of cable is scrapped.

Isotope Products Wing Designed for Radiography

Canada's only gamma radiography specialists, Isotope Products, annually use hundreds of radioactive sources and miles of supersensitive film to inspect welding, check castings, and probe a wide range of industrial materials. Some of these sources produce gamma rays capable of penetrating foot-thick steel. At the same time, the radiography film is sensitive enough to be affected by 20 milliroentgens of radioactivity. This is about 1/50th of the dosage that a human being receives in a chest X ray.

Storing the radioactive sources and the film in the same building, and working with these materials, requires special care if film is not to be accidentally fogged. Now under construction is a 3,000-square-foot addition to Isotope Product's Oakville plant, which will incorporate specially designed facilities for radiography. A radiography laboratory will be separated from adjacent rooms by a foot-thick reinforced concrete shielding wall. And a film storage vault will secure film within a dozen feet of the laboratory area where radioactive sources are exposed.

The company's present 4,000-square-foot plant will be extended by a 102- by 31-foot wing that forms a right angle with the existing building. Sales, purchasing, engineering, and general offices will occupy space both sides of a central corridor in the new wing. Beyond them will be a board room and library and radiography offices. Then occupying the south end of the wing will be darkroom facilities and the radiography laboratory. These facilities will all be in the one story above-ground wing. The film storage vault will be below ground, availing of subsurface soil—"the most inexpensive radiation shield"—to augment reinforced concrete walls.

The radiography laboratory will be about 14 by 30 feet; divided near the center by a concrete baffle wall that angles across the room. The baffle wall will form a shallow (120-degree) V. One arm of the V will form a partition wall separating the exposure end of the laboratory from the remainder of the building. The other arm angles across the laboratory to confine any radiation to the exposure area.

The baffle wall, constructed of 12-inch 2,000-pound reinforced poured concrete, will rise from the footings through the full height of the building. It will thus insulate both the above-ground wing and the subsurface film vault. The floor of the radiography laboratory will be 3,000-pound concrete slab with a special hardening admixture for heavy duty service. Exterior walls of the laboratory will be of the same construction as the remainder of the building: cement asbestos board.

The film storage vault, about 7 by 11 feet, will be contained by 10-inch reinforced concrete walls on all sides. These walls will comprise part of the footings of the building. The vault will have a 5-inch reinforced concrete slab floor and be roofed by a similar floor at ground level. Located directly below a radiography viewing room, the film vault will be reached from this room by a stair. Between the viewing room and the exposure area of the radiography laboratory will be a 9- by 11-foot darkroom. The baffle wall separates the exposure area from the darkroom.

Micro-Miniature Triode Developed for Electronic Equipment

A new concept in receiving tube design was announced and demonstrated in the form of a tiny micro-miniature ceramic triode for uhf-television sets by the General Electric Company recently.

The micro-miniature triode—*6BY4*—is an all metal-and-ceramic tube about 3/8 inch long and 5/16 inch in diameter. Preliminary ratings on this particular tube are based on an operating frequency of 900 mc. Development work indicates that production models soon will be available with a noise factor of approximately 8 db, and a power gain of approximately 15 db when operating at this frequency with a bandwidth of 10 mc.

The practical development of the *6BY4* at the company's Receiving Tube Sub-Department in Owensboro, Ky., followed several years of fundamental research in tube design, ceramic material, and titanium at the company's research laboratory in Schenectady. Although the tube features micro-spacing of elements and a grid of approximately 1000 turns per inch, the micro-miniature design permits the development of simplified production techniques which should allow a relatively low price. The design and manufacture of the tubes represents a departure from conventional techniques of quantity tube manufacture.

While the tube cathode normally is heated with a filament in the conventional manner, a demonstration with a blow torch applied to the outside of the tube showed how it also will operate when heated by an external source.

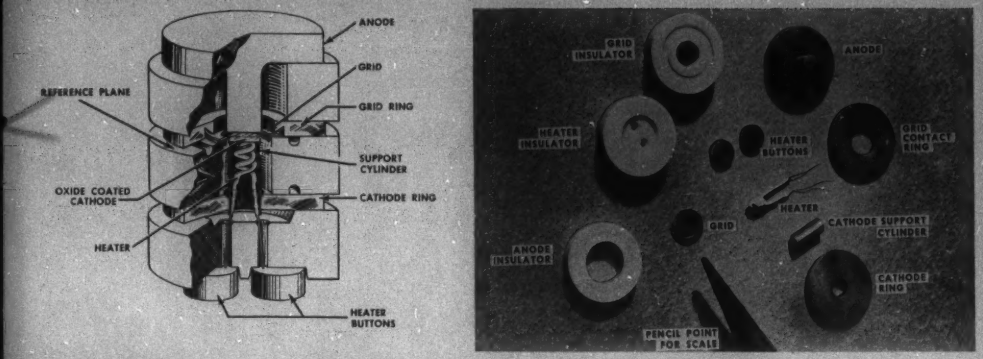
The grid assembly for the tube is made from tungsten wire only .0003 inch in diameter—so fine it is virtually invisible under normal room lighting. Nevertheless, the wire is wound and brazed to a small tungsten washer at a pitch of 1000 turns per inch. Special machinery developed by engineers perform this delicate operation.

Extensive ceramic research was necessary to develop the material used for the spacers in the tube. It was necessary to find a low-loss ceramic with appropriate expansion characteristics, dimensional stability, and vacuum-tight sealing characteristics not previously used in vacuum tube manufacture.

The exhaust and sealing techniques used in the manufacture of the vacuum tube have resulted in seals that remain vacuum-tight at temperatures in excess of 700 C.

Representatives for the company feel the new receiving tube design which required

SMALL SIZE of the 6BY4, General Electric's new micro-miniature ceramic receiving tube, makes it difficult to photograph even in near-life-size scenes.



SCHEMATIC DIAGRAM (left) of tiny micro-miniature ceramic tube, type 6BY4, designed specifically for uhf-television tuners and converters. The new vacuum tube is only 3/8 inch long and 5/16 inch in diameter. Tiny parts of new receiving triode (right) compared with pencil point for size.

so much research in new materials, processes, and assembly methods will bring into focus new horizons in standards for noise figures, uhf amplification, ruggedization, miniaturization, and extreme operating temperature specifications. The General Electric Company's engineers see the possibility of a complete line of these tiny electronic tubes from diodes to complex multielement tubes. Possible applications include mobile and industrial communications, airborne and mobile radar, industrial controls, guided missile controls, nuclear power controls—possibly even man-made satellites. In general, any manufacturer of electronic equipment requiring motion, high temperature, restricted space, automatic assembly, or uhf performance may find the micro-miniature tubes useful.

Shoran Equipment Speeds Project for Extensive Land-Mapping

Shoran, a high-precision position-finding radar system developed by Radio Corporation of America (RCA) during World War II for aerial navigation, is providing "seven league boots" for one of the most extensive land-mapping projects ever undertaken.

The system will enable Canadian Aero Service Limited and its affiliate, Spartan Air Services Limited, to complete in only four summers a geodetic and photographic grid survey of more than a half-million square miles of the Canadian far north—a project which would require decades with usual mapping techniques.

The Shoran survey, now in its fourth year, is being made for the Army Survey Establishment of the Canadian Department of National Defense, and covers a largely unmapped area on both sides of the Arctic Circle. The survey area is bounded by Hudson's Bay on the southeast, the Northwest Passage on the north, and the Mackenzie River on the west.

Canadian Aero and Spartan are using six land-based Shoran field stations. These are moved progressively as each unmapped section is geodetically and photographically surveyed. Two air-borne units are at work in the survey aircraft.

The position-finding electronic aid is enabling Canadian Aero and Spartan mapping crews to measure, with unprecedented accuracy, many geographic points 200 to 300 miles apart. The aerial measurements are made in a fraction of the time required to measure points only several miles apart with conventional ground surveys.

Shoran, initially developed for military applications, is a radio-controlled navigation system which enables an airplane to determine electronically its position over a given area. It eliminates the dependency upon established control points or precisely known landmarks. In wartime applications it was used for precision bombing and reconnaissance aerial mapping.

In operation, a Shoran-equipped plane transmits radio signals to each of two ground stations which receive and immediately relay the signals back to the plane. Automatic, electronic measurement of the time required for the signals to make the round trip permits computation of absolute plane position with respect to each of the two fixed ground stations.

Scientists Discover Elements 99 and 100

In a joint letter to the editor of *Physical Review*, scientists at the Argonne National Laboratory, which is operated for the U. S. Atomic Energy Commission by the University of Chicago at Lemont, Ill., the Los Alamos Scientific Laboratory, N. Mex., and the radiation laboratory and department of chemistry at the University of California, Berkeley, have described the results of cooperative experiments performed at their laboratories which resulted in the discovery of elements 99 and 100.

The source of the material which was used for the first chemical identification of these elements was radioactive debris collected from a thermonuclear test carried out in the Pacific Ocean late in 1952. Element 99 was produced via the instantaneous capture by uranium 238 of 15 neutrons. This resulted in an unstable uranium 253 nucleus, which quickly transformed into element 99 (weight 253) by the emission or loss of 7 beta particles. In a similar manner, the capture of 17 neutrons and loss of 8 beta particles resulted in the formation of element 100 (weight 255). This work, which has just been declassified, was done prior to the reported production of these elements by cyclotron and reactor bombardments.

The letter, which was signed by the scientists and published in the August 1, 1955 issue of the physics magazine, suggests that the elements be named after Albert Einstein and Enrico Fermi, two prominent scientists who died recently. The name einsteinium (symbol *E*) is recommended for element 99, and fermium (symbol *Fm*) for element 100.

Closed Circuit Television Tried in Airline Operations

The first airline use of closed circuit television is underway at the Portland Airport, Ore., where United Air Lines is testing television as a fast, efficient way to disseminate flight information.

The experimental telecasts originate in United's dispatch office—central source of flight information—where arrival and departure times are posted on a large plexiglass panel. A television camera, focused on the panel, transmits pictures over coaxial cable to four receivers in the terminal building. One receiver is in the telephone sales office, another in the ramp chief's office, and two are in the lobby for public viewing.

Flight information ordinarily is reported to various departments by telephone and telemeter. As compared with this method, closed circuit television thus far has been found to have the following advantages: (1) faster reporting of arrival and departure times to the public; (2) simultaneous reporting to all departments; (3) elimination of exposure to error through transcribing or transmitting flight information; and (4) elimination of duplicate effort, since agents no longer have

FLIGHT INFORMATION PANEL, televised from the flight dispatch office of United Air Lines at Portland Airport, Ore., is viewed by travelers on two receivers in passenger lobby. There is another receiver in the telephone sales office and the ramp chief's office; This is the first application of closed circuit television in airline operations.

H. C. WARRINGTON (left), superintendent of research and development for United Air Lines, adjusts television camera suspended from ceiling of flight dispatch office in Portland, Ore., Camera is focused on flight information panel at which T. Petty, lead load planner, is posting schedule changes. These changes are seen at the four television receivers in the terminal building. The installation is the result of tests by United and the Kay Lab Corporation of San Diego, Calif.

to post changes on flight information boards in the lobby and telephone sales office.

The Portland installation is the result of tests 18 months ago by United and the Kay-Lab Corporation of San Diego, Calif., makers of industrial electronic equipment. Portland was chosen for a full-scale test because all of United's offices there, except a downtown ticket office, are under one roof. Inter-city use of closed circuit television and transmission to receivers at remote locations are now being explored. If the Portland tests prove satisfactory on all counts, similar installations may be made at major stations on United's 13,250-mile system.

Television Effective in Supervising Highway Traffic

Deep in a half-mile highway tunnel piercing a West Virginia mountain ridge, motorists are as close to the outdoors as the nearest television set—and the closest one is but a few feet away, extending an invisible helping hand from entry to exit.

Camera and monitoring equipment produced by the Dage Television Division of Thompson Products, Inc., keep a sharp electronic eye on the lookout as an extra safety feature for the scores of automobiles daily traversing the $4,000,000 Memorial Tunnel near Charleston on the West Virginia Turnpike.

Four cameras are suspended at intervals above the tunnel roadway, one covering the entire length and the others focused for "close-ups" along the route. The pictures "overlap" so that a motorist is always "seen" by at least one camera. The images are flashed over the closed circuit system to four receivers, or monitors, installed in an office at one end of the tunnel. Here two turnpike employees scan the monitors and can control the traffic stream from a desk chair. The observers know watching the screens whether traffic is moving smoothly and all control and roadway conditions are normal.

If a car should become stalled a tunnel watcher, observing on television an approaching traffic snarl, can switch on stop lights at either end of the tunnel halting oncoming traffic, until the disabled car can be started and moved along. Thanks to television, he can spot a trouble point immediately and, if necessary, dispatch a turnpike trouble car to the precise location where it is needed.

The Dage installation, which already has proved its effectiveness and economy in its first 6 months of operation, provides an eagle-eye perception in the interests of greater safety for the motorist, while also making traffic control easier.

New Brain Wave Apparatus Made Portable for Convenient Use

Offner Electronics, Chicago manufacturer of electromedical equipment, has announced the development of the first transistorized portable electroencephalograph. This unit was introduced recently at a convention of the American Electroencephalographic Society in Chicago, Ill.

Dr. F. F. Offner, president of Offner Electronics, says this new unit, the only one of its kind in existence, will alter radically and enlarge the use of this type of electromedical equipment. The new unit is light and portable; with a recorder it is housed in two suitcase-type containers.

Electroencephalographs are large, complex instruments used to record signals of the brain only a few millionths of a volt in strength. The new unit, while only a tenth the size of laboratory models, has channels for recording eight signals from the brain simultaneously, and exceeds the sensitivity and accuracy of many larger models now being used. The major difference in the new instrument is in its use of transistors in place of vacuum tubes. Not only are the transistors much smaller than the tubes they replace, but are operated from flashlight batteries instead of the heavy power supplies needed for the vacuum tubes. Plug-in amplifiers are used in the instrument and have been reduced in size to a 2- by 3-inch unit that can be replaced in seconds.

The new unit is expected to be available commercially in January 1956, for clinical and experimental use.

Scientists Measure Thyroid I-131 Uptake

Scientists at seven leading research institutions are undertaking a new study designed to test the methods for measuring the amount of radioactive iodine absorbed by the human thyroid gland, and they are being assisted in the work by seven beautiful dolls.

The use of radioactive iodine to measure thyroid metabolism has been increasing

enormously during the past few years, but the measurements of the thyroid's uptake of the isotope as performed by many different techniques have yielded highly variable results. In an attempt to perfect a uniform technique that will produce accurate results under all test conditions, scientists in various cities are collaborating in an informal iodine-uptake survey.

The seven "dolls" are actually seven half-body mannequins with artificial thyroid glands. The mannequins are made to resemble the upper half of a human body as closely as possible, to emphasize the point that the test is to be carried out as though it were actually being made on a human being and not as a special test in physics.

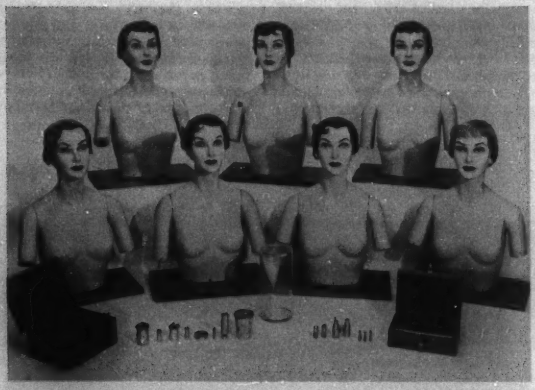
Instead of ordinary radioactive iodine, which loses half its energy every 8 days and is therefore unsuitable for long-range testing, the artificial thyroids will contain a substance called "mock-iodine." This mock-iodine is composed of a mixture of radioactive barium and cesium. Its radiation characteristics, for the purpose of the test, are similar to those of Iodine 131. The mixture offers the advantage of having a useful life of more than ten years.

At the beginning of the test the mannequins, loaded with varying dosages of mock-iodine, are shipped from Oak Ridge to scientists at six research institutions. These scientists are Dr. Robert T. Neiset, Tulane University, New Orleans, La.; Dr. Edgar S. Gordon, University of Wisconsin, Madison; Dr. Raymond L. Libby, Los Angeles (Calif.) Veterans Administration Hospital; Dr. A. Stone Freedberg, Beth Israel Hospital, Boston, Mass; Dr. Herbert D. Kerman, University of Louisville (Ky.) Medical School; and Dr. T. H. Oddie, University of Arkansas Medical School, Little Rock. Each physician makes a measurement of the iodine uptake of the mannequin, using a standard procedure.

In addition to these tests, physicians in the locality of each institution are invited to make similar uptake measurements; these results are identified by code numbers. When the mannequins have all been adequately tested, each at its separate institution, they are sent to the next institution on the list and the procedure is repeated. By the time each mannequin has been tested at each of the seven institutions, between 300 and 400 tests results will be available for study and comparison.

The experiment will continue throughout the next year. In April 1956, when the third advanced course in the medical use of isotopes will be held, these results will be discussed. It is expected that, at the conclusion of the experiment, a standard test technique will be established that will enable any properly trained physician to make precise and accurate measurements of iodine uptake by a patient receiving treatments involving the use of radioactive iodine.

There is reason to believe that, before 1956, many persons involved in the testing procedure will wish to improve their techniques. For this purpose, special calibration kits have been prepared that can be used to calibrate reasonably well any type of equipment and any method of measuring thyroid uptake. A kit will be sent to each area representative for use in assisting physicians in his area. These kits should be ready shortly after the mannequins are available. A series of calibration kits have been sent to the National Bureau of Standards, Radioactivity Section, Washington, D. C., who will collaborate in the calibration program.



THE MANNEQUINS ABOVE are the seven being used in a nation-wide experimental study techniques for measuring uptake of radioactive iodine by the human thyroid. Their names are Abigail, Bridget, Chloe, Drusilla, Euphemia, Felicia, and Grenadine. Also shown is a thigh section for supplementary checking, and some of the material used to prepare the mannequins for the test.

Transistor Made to Perform at Record-High Frequencies

Bell Telephone Laboratories has announced that a new record has been achieved in operation of transistors at high frequencies. Experimental "junction tetrode" transistors have generated more than a billion oscillations per second.

Bell scientists have succeeded in stepping up the performance of these minute solid-state amplifiers well into the uhf-range that is used for certain types of radar and communications systems carrying television and large bundles of telephone conversations. This was accomplished by the addition of a fourth electrode to the basic junction transistor, plus other refinements.

ATOP the four vertical "posts" in the photograph are the inner working parts of an experimental transistor developed by the Bell Telephone Laboratories. This device has been used to produce more than a billion oscillations per second. The tiny wires shown are made of gold and are less than half as thick as a human hair.

The device has been made to perform at very high frequencies by reducing the width of the germanium bar and the central *p*-layer, and by adding a fourth electrode. New techniques for producing the thin middle layer have recently made possible an almost tenfold reduction in its width. In the billion-cycle transistors, this layer is less than 0.0002 inch wide.

Telephone engineers are especially interested in broadband devices, such as the junction tetrode transistor, which enable hundreds of telephone conversations to be carried over a single pair of wires at one time. Until now this job has been done exclusively by vacuum tubes.

While the new transistors are still in the experimental stage, progress has been made in learning to control processes in making them. Production by the Western Electric Company is scheduled for this year, with initial output directed toward defense needs.

Outdoor Telephone Sets Used to Summon Aid in Emergencies

"Fire!" "Police!" The cry for help can now be telephoned directly by the public from street corners.

A new telephone system, developed at Bell Telephone Laboratories, may eventually become as commonplace as the familiar red fire alarm boxes in which a handle is pulled to send out a telegraphic signal. Outdoor telephone sets encased in brightly painted cast aluminum housings are mounted at street corners. The spring door can be flung back quickly and the receiver snatched from its hook to summon aid in any emergency. The system enables firemen or

THE PUBLIC can now telephone directly from street corners during emergencies for fire or police assistance. This new system was recently developed at Bell Telephone Laboratories.

policemen to talk directly with the person placing the alarm. They can immediately determine the exact location of the emergency, its extent, and the best type of equipment to dispatch.

In a typical installation, when a call is made, a light flashes on a console at alarm headquarters until the call is answered. The light shows the box number and its location. There are no switches or dials; the caller is in direct contact. The console light remains on after the dispatcher answers until released by the operator so he knows where the alarm is coming from even if the person reporting the emergency is too excited to talk. If the call is for police, the fire department operator immediately transfers the call to the police department switchboard. Calls may be relayed from one switchboard to another. An automatic voice recorder flips on when the call comes in to take the caller's report. Another recorder can be provided which marks the time and box location.

An optional feature of the system which may be provided is a special by-pass switch which enables foot patrolmen to report directly to police headquarters without having calls go through the fire department.

All reporting lines are under continuous electrical test which signals the operator at the console and the telephone company in the event of damage to the circuits.

A number of cities, including Omaha, Neb., Indianapolis, Ind., Miami, Fla., Syracuse, N. Y., and Sioux Falls, S. D., have approved the use of the system.

ARDC Designs Personnel Aircraft Detector

An electronic device designed to tighten the United States air defense has been developed for the Ground Observer Corps (GOC) by the Air Research and Development Command (ARDC).

The device, developed by engineers of ARDC's Rome Air Development Center at Griffis Air Force Base, Rome, N. Y., is a 20-ounce portable detector designed to add electronic eyes to the GOC during periods of darkness or poor visibility.

Mounted on a hat, the receiver operates on the basis that any enemy aircraft penetrating defenses would be forced to use nonoptical methods of navigation and bombing under low-visibility conditions. The radar from this aircraft would radiate large bursts of high-frequency energy which are easily detected by GOC personnel equipped with the detector. When an aircraft operating under these conditions nears the site of the observation post the receiver would automatically pick up the signal. The observer would immediately telephone the enemy's position to the appropriate filter center.

Incorporating transistors with printed circuits as a pulse amplifier, the equipment also includes a 4-ounce battery pack as a power source and a horn antenna which receives high frequency. A crystal mounted in the stem is used as the detector. The attachment link is a coaxial choke assembly with a filtering action so as to deliver a sharp pulse to the amplifier. The positive pulses from the output of the detector and coaxial choke are fed directly into the pulse amplifier and then into lightweight earphones. The low power drain makes operation possible for a week under normal conditions.

Network Calculator Installed at Wisconsin University

A new Westinghouse 15-generator a-c network calculator has recently been installed in the electrical engineering department at the University of Wisconsin at Madison. The calculator was purchased by the Wisconsin Utilities Association and was presented to the University in August. Contributors to the project are: Wisconsin Electric Power Company and Associated Companies, Wisconsin Power and Light Company, Wisconsin Public Service Corporation, Northern States Power Company, Lake Superior District Power Company, Madison Gas and Electric Company, and Allis Chalmers Manufacturing Company.

The new installation will be in operation this fall. Dr. J. J. Skiles of the electrical engineering department staff will be in charge. The new calculator will enable utilities in the state to study their system problems. Also, the proximity of additional calculating equipment in the numerical analysis laboratory makes it possible to explore the advantages of new tolls and techniques in connection with system problems. This equipment includes an International Business Machine Company *CPC* and a *650* magnetic drum computer. A magnetic drum intermediate speed digital computer known as the *WISC* under construction in the electrical engineering department during the past 4 years is nearing completion, and high-speed analogue equipment has been available for several years for educational and research purposes.

AEC Research Reports Made Available to Industry

The Department of Commerce has undertaken a stepped-up program, through a cooperative arrangement with the Atomic Energy Commission (AEC), to make public as promptly as possible nonclassified AEC research reports of industrial significance, Secretary of Commerce Sinclair Weeks announced recently.

As the first move in this program, 961 of the most important reports selected from the AEC accumulation of research were made available through Commerce's Office of Technical Services. About a third of these reports had limited circulation in the past, but most of them have not been previously published. The reports cover many areas of scientific and industrial interest including chemistry, geology, metallurgy, mineralogy, ceramics, instrumentation, physics, and reactor technology. They range from general studies such as "Fission Products Utilization" to such titles as "Radiation Stability of Plastics and Elastomers," "Surface Preparation of Zirconium for Brazing," and "The Titanium-Vanadium System."

The AEC will turn over to Commerce on a continuing basis reports of new research as well as additional reports of earlier research as they are released.

Commenting on the arrangement between Commerce and AEC, through which the accumulation of technical knowledge of scientific and industrial applications of the atom will be made public, the Secretary said it was the desire of the Government to make all beneficial unclassified information developed through Government research available to industry. "The release of this information to American industry complements President Eisenhower's 'atoms for peace' program on the home front. American industry must have all available information if we are to realize the full application

New network calculator laboratory at the University of Wisconsin.

of atomic energy to peaceful uses. The release of these reports marks the beginning of a wider participation of industry in atomic research and development."

The 961 reports released are listed in a "List of AEC Research Reports for Sale," which may be obtained free from the Office of Technical Services (OTS), U. S. Department of Commerce. Reports released in the future will be abstracted in OTS's monthly publication "U. S. Government Research Reports," available at $6 a year from the Superintendent of Documents, Government Printing Office. They will also be listed in subsequent "Lists of AEC Research Reports for Sale," which will be publishedt wice a year.

The Office of Technical Services serves as a clearinghouse for Government research which may be of interest to private industry. With Government research costing more than two-billion dollars a year, OTS collects several hundred non-nuclear reports each month from the Army, Navy, Air Force, and other agencies, and now has a collection of over 250,000 research documents.

Added to this will be the AEC reports which will be handled in the same way as other research reports collected by OTS. The most important will be reprinted and sold at the cost of printing and handling by OTS. The others will become depository items at the Library of Congress. Photocopy or microfilm reproductions of these reports can be purchased from the Library. All reports will be described in the U. S. Government Research Reports.

Flight Simulators Used to Train Air Crews

Two international air carriers, *KLM* and *Air France*, have each ordered a simulator for delivery in 1956 from the electronics division of the Curtiss-Wright Corporation. The unit for *Air France* will reproduce electronically the Lockheed Super Constellations that the French national airline is operating on its runs across the North Atlantic. The simulator which *KLM* has specified will duplicate the flight characteristics of the forthcoming Douglas *DC-7C* high-speed, long-range transport that will go into intercontinental service in 1956.

Built around the flight deck of the plane they reproduce, simulators "fly" and handle like a true aircraft; they were pioneered to provide a method whereby air crews could develop team co-ordination and keep flight skills at peak proficiency.

Each of the simulators for *KLM* and *Air France* will include an instructor's compartment separated from the cockpit by a curtain, equipment to reproduce radio and directional signals found on any established airway in the world, and flight recording instruments so that air crews will have a permanent record of their performance each time they use the simulator.

Simulators, although they never move, are made to fly realistically through the use of analogue computers which continuously solve differential equations expressing the motion of a plane in flight. Realistic sound effects, including the squeal of tires as the simulator touches down on the runway, add to the sensation of being airborne, and a trouble console permits the introduction of a wide range of emergencies so that corrective procedures can be developed by air crews in perfect safety.

New Air Valve Protects Press Operators

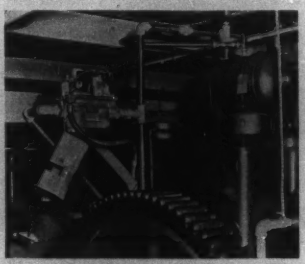
Increased safety for operators of large metal stamping presses is provided by a new protector air valve developed by the Clark Controller Company. The company also revealed that it has a new anti-repeat control for presses incorporating transistors instead of moving parts. The new controls are intended for use on all presses that have clutches or brakes, or a combination of the two, operated by air pressure, including the huge presses which turn out large automotive body parts.

For safety reasons, presses are automatically stopped at the end of each stroke by an electrically operated valve, which exhausts air pressure to release the clutch and set the brake. Another stroke cannot begin unless each man working on the press has both hands depressing push buttons. This insures that his hands are away from the danger area while the press dies are being squeezed together.

Anti-repeat controls are designed to prevent accidental repeat operation of the press when operators' hands are not depressing the push buttons. They are made as nearly "fail-safe" as possible, which means that failures in the control system—such as a power failure, a short circuit, or a stuck push button—will act to stop the press rather than to make it operate unexpectedly.

The electric control systems have been as nearly fail-safe as possible, and as much safety as possible had been built into the single air valve which the electric control operates. For even greater protection, the new development adds a safety unit to the operating air valve. This is a second valve, also capable of releasing the air pressure from the press clutch and of setting the brake. This valve stands by in normal operation, but operates instantly to stop the press if the operating valve fails to function properly.

The electric anti-repeat controls which operate air valves usually include several relays operated by electromagnets. These



NEW TYPE PV protector valve, for presses with air-operated clutches or brakes, or a combination of the two, as installed on a press. Made by Clark Controller Company, the new valve has stand-by safety unit which operates to stop the press if operating unit fails to function.

AIR-CLUTCH PRESS, equipped with new protector valve, is in Clark Controller's plant. Worker must depress two push buttons, as shown, to make valve admit air to press clutch, thus cannot have his hands in danger while dies close. New protector valve (above large gear at top left) guards against failures which might allow press to operate when hands are off the push buttons.

moving parts are subject to wear. This is not a serious safety problem, since the controls are designed to be as fail-safe as possible, but this wear does present a maintenance problem. The Clark Controller is well advanced in the application of transistors to solve this problem. In the anti-repeat press control, transistors, which have no moving parts, perform the functions handled by relays in conventional controls.

Automatic Machine Designed for Wiring Electric Apparatus

Bell Telephone Laboratories have developed an ambidextrous machine that can automatically wire complex electric apparatus.

The experimental machine, called the *M-4*, was developed to study apparatus and equipment designs best suited for automation. It can neither see nor hear, but it can "feel" and thus follow instructions with great accuracy. Instructions are fed to the machine from a punched tape. A series of relays, acting as the machine's "brain," translate this information into electric signals. The signals then control the cams and gears of the machine.

The *M-4*, designed by R. F. Mallina, uses a process for making solderless wrapped connections, also started at Bell Laboratories. This process, applied by hand-controlled tools, is now used for important production work by the Western Electric Company. Connections are made by automatically wrapping six turns of solid-conductor wire around a rectangular terminal. The high wrapping tension provides an airtight, corrosion-resistant contact between the wire and terminal at numerous points.

The experimental machine uses two rotating spindles. The wire is fed directly from a large spool. One spindle pulls the wire, in an inverted L-shaped movement, to a connecting terminal. At the same time the wire is cut to the correct length at the second spindle. The spindles remove a small amount of insulation from each end of the

(Left) CLOSE-UP of the M-4 machine developed by the Bell Telephone Laboratories. Instructions are being fed to it from a punched tape, held here by R. F. Mallina who designed the machine. A series of relays in the background act as the "brain," translating this information into electric signals. (Above) Two 5-tube radio receivers; the one on the right has been wired by ordinary soldering methods, that on the left by the process the M-4 uses for making solderless wrapped connections.

wire as they whip the bare wire ends around the terminals. This produces a pressure of about 15,000 pounds per square inch at each contacting area. Following their punched tape instructions, the spindles then pick up the supply wire from the spool and move to the next electric connection where the process is repeated. Machine wiring eliminates the need for preparing, storing, and handling many short pieces of wire.

The *M-4* can be used in conjunction with plastic panels, all alike, on which are mounted different groups of electric parts such as electron tubes, or transistors, resistors, and capacitors. The terminals of the parts protrude through holes in the panels spaced at regular (modular) intervals.

It can be visualized that when suitable apparatus and equipment designs are ready for manufacture several machines developed along the lines of the *M-4* might be used at once, all receiving instructions from a common "brain." The machine is a distant cousin of textile industry machines which handle and interconnect thousands of threads more delicate than wire.

AEC Ships Technical Libraries on Nuclear Energy to 23 Nations

Lewis L. Strauss, Chairman of the Atomic Energy Commission (AEC), announced that technical libraries of nonclassified data on nuclear energy and its applications have been shipped to 23 nations. These comprehensive collections, each containing the equivalent of documents which would fill 250 feet of library shelving, were developed by the AEC Technical Information Service as one of the several Commission projects supporting the President's atoms-for-peace program.

Each gift library, weighing approximately 1,000 pounds, consists of approximately 6,500 AEC research and development reports, 5,000 of which are on microcards; 22 miscellaneous books; 34 bound volumes of scientific and technical texts on nuclear theory; and 11 bound volumes of abstracts of some 50,000 reports and articles published in the United States and abroad. Each collection also will include about 55,000 index cards which will be shipped later.

The individual collections duplicate material now available in 42 repository libraries in the United States, three in the United Kingdom, and one each in Belgium and Canada.

Libraries have been shipped to the following nations: Italy, Spain, Australia, Sweden, Greece, Egypt, Burma, Denmark, Austria, Philippines, Finland, Turkey, Netherlands, New Zealand, Portugal, Peru, South Africa, Israel, Norway, India, Argentina, France, and Japan.

Communications Equipment Survive Atomic Blast in Tests

First official details on the effect of an atomic blast on commercial communications equipment have revealed that radiobroadcast and 2-way mobile radio equipment built by the Radio Corporation of America suffered only minor surface damage and could have returned to the air minutes after the nuclear explosion.

The civil defense phase of the test, conducted May 5 at the Atomic Test Site in the Nevada desert some 90 miles from Las Vegas, was made under auspices of the Federal Civil Defense Administration and included participation of member companies of the Radio-Electronics-Television Manufacturers Association.

The Radio Corporation of America provided a standard commercial 250-watt radio transmitter and associated equipment for a fully operative AM broadcast station; a complete mobile radio base station operating in the 25- to 50-mc range; and two mobile radio units installed in automobiles. All the equipment was housed less than a mile from the blast center, with the exception of one 2-way radio located 10,500 feet away.

Although the buildings and automobiles in which the equipment was installed suffered partial-to-complete destruction, the transmitter, mobile station, and 2-way radios remained completely operative and suffered only surface damage caused by flying glass and debris. The blast had virtually no effect on the AM station's antenna tower, but snapped the smaller one erected for the mobile radio station. The 250-watt radio transmitter, housed in a building which was damaged heavily, came through unscathed but suffered a power break when power lines connected to an outside gasoline generator were snapped by falling telegraph poles. The broken lines were repaired in less than 15 minutes.

The house which held the installed mobile radio station was demolished, and the station equipment was hurled from the second floor to the top of a pile of debris at ground level. However, the equipment was operative when inspection teams arrived on the scene.

The radio-equipped automobile closest to the blast center, parked outside the transmitter building, was reported wrecked but its 2-way radio suffered only minor scratches and dents and remained operative. The second car, 10,500 feet from the blast center, suffered only slight damage and its 2-way radio was untouched.

The purpose of the experiment was to determine whether commercial electronic communications equipment would remain operative under detonation conditions or, if failures developed, to determine the nature and extent of damage and the time and repairs required to return the equipment to service.

Government of Colombia Studying Electrification Program

A long-range electrification program calling for a total expenditure of approximately $1,200,000,000 by 1970 is being studied by the government of Colombia, S. A. The plan will progressively increase that nation's power generating capacity from its present 338,000 kw to 2,695,000 kw by that year. Transmission and distribution facilities are to be expanded accordingly.

The study which produced the program was jointly undertaken in 1953 by Gibbs and Hill, Inc., New York consulting engineers, and Electricite de France, the French national power utility. The two organizations carried their assignment jointly in co-ordination with the Colombian National Institute of Water and Electric Power Development. The purpose of the program is to provide power essential to Colombia's planned industrial and economic growth.

The program was submitted to Sr. Dr. M. A. Monroy, Colombian Minister of Development. It contemplates an increase in power generating capacity to 1,150,000 kw by 1960, to 1,792,000 kw in 1965, and 2,695,000 kw in 1970. It is estimated that one-half of the total sum required to bring the program to fruition will be expended for the purchase of equipment outside of Colombia.

Operations Analysts Train for Air Force at Penn. Univ.

The University of Pennsylvania will prepare a group of civilian scientists to serve as Air Force operations analysts in the event of a major national emergency.

Under Air Force contract, the Institute for Co-operative Research at the University will form an "operations analysis stand-by unit" of some 10-to-20 men, drawn mainly from its own faculties, according to Dr. C. C. Chambers, the University's vice-president for engineering affairs and acting director of the Institute. Dr. J. P. Bursk, chairman of the department of economic and social statistics in the University's Wharton School of Finance and Commerce, will be project director.

Operations analysis, the use of scientific methods to solve problems of almost any kind, is applicable to Air Force activities ranging in variety from feeding to strategy. Unit members will include mathematicians, statisticians, engineers, and specialists in the various physical and social sciences. They will devote an average of 40 days annually to indoctrination in operations analysis and Air Force procedures. The program will include lectures, meetings, trips to Air Force installations, conferences with operations analysis officers in various commands, and the solution of specific problems. In case of a national emergency, the members will be available to serve with the Air Force in full-time civilian status.

150 Consulting Engineers Confer on Aluminum Busway Systems

The Aluminum Company of America (Alcoa) recently held a short seminar for consulting engineers in New York, N. Y., on recent electrical innovations of aluminum in the industrial and monumental building fields. A brief talk, "The Development of Aluminum Busway Systems," was given by Robert R. Cope, head of the electrical section, development division, at New Kensington, Pa.

Aluminum bus has found increasing favor in a wide variety of manufacturing, chemical, and electrical installations. Many of the problems involved in its use have been solved in Alcoa's own plants where more than 40-million pounds of aluminum bus are in operation.

Nontracking Butyl Insulation Developed for High-Voltage Uses

An important advance in the search for better organic insulation materials was made by the General Electric Company with the discovery of a way to fortify organic compounds against high-voltage electric discharges—a long-sought goal in the search for better insulation materials.

E. E. Parker, general manager of the company's instrument department, Lynn, Mass., said this reinforced butyl compound has proved superior to porcelain under conditions of severe electric discharges. The new material, *HY-BUTE/60*, incorporates a chemical mechanism that prevents formation of free carbon at high temperatures. This eliminates the carbon tracks that appear on the surface of ordinary organic insulations when exposed to electric arcs, which has been the chief limitation to the use of such materials in exposed applications at high voltages.

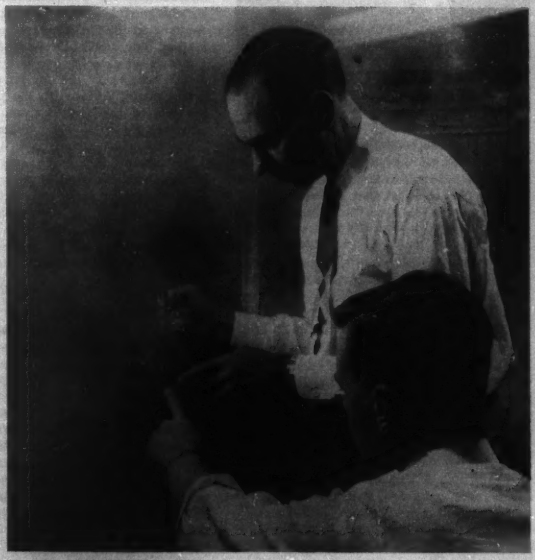
The new insulation promises to have a broad range of applications in the electrical industry, but its first actual use will be in high-voltage outdoor instrument transformers of the molded butyl type for 15,000 volts and above. Gaskets, porcelain bushings, steel casings, and insulating oil used in the construction of present high-voltage instrument transformers will be eliminated. "This means trouble-free, one-piece construction that virtually eliminates maintenance and susceptibility to mechanical damage," Mr. Parker said.

The General Electric Company pioneered the use of ordinary butyl for the molding of low- and medium-voltage instrument transformers in 1949. Efforts to develop a reinforced butyl for high-voltage uses have been underway at Lynn since that time.

Small Silicon Diodes for Industrial Power Rectification

Newly available Westinghouse power silicon diodes, capable of handling kilowatts of power, begin a new era of industrial power rectification. In the next few years, silicon will almost certainly replace selenium in all types of applications and may even seriously challenge high-voltage electronic rectifiers. The two outstanding advantages of fused silicon diodes are the high efficiencies even in low-voltage systems and the ability to operate at temperatures from −65 C up to 190 C.

The theoretical potentiality of silicon as a power rectifier has been recognized for several years; in fact, several low-power silicon diodes capable of operating at high temperatures have become commercially available within the past year. These diodes have had voltage drops at maximum rated forward current ranging from several volts down



THE CURRENT TRANSFORMER shown has survived 1,400 hours at full voltage in a salt-fog torture chamber. The torture test determined the ability of the General Electric Company's new nontracking organic insulation material, HY-BUTE/60, to withstand extreme atmospheric conditions. R. A. Pfuntner, standing, and B. W. Wilterdink are the engineers who applied the material to the molding of outdoor instrument transformers rated at 15 kv and above.

to about 1.5 volts. The internal heat generation is nearly proportional to the product of this forward drop and the maximum current. Thus, it is extremely important that this value be as small as possible in order to make practical a rectifier having rated currents in the range of 10 to 100 amperes.

In view of this limitation, a long but successful development program to reduce this drop to nearly the theoretical value was initiated. As a consequence, these new diodes have a typical drop of only 0.7 volt at a current of 8 amperes and at a cell temperature of 190 C.

To appreciate the characteristics of these units, one need only compare them with a typical commercial selenium stack of equal current and voltage ratings. For example, the rating of the new rectifier, when mounted in a finned case 1 inch high and $1^1/_2$ inch in diameter and having natural convection cooling with a 65 C ambient, is 15 amperes

SMALL Westinghouse silicon power diode in the foreground has the rectifying capacity of selenium rectifier the same size as large block in the background. Dark corner of block represents volume of silicon rectifier—a 70-to-1 reduction.

at 200 volts peak inverse. A selenium rectifier capable of carrying 15 amperes at this ambient would require plates of 45-square inch cross section. Since the commercial voltage rating per plate is only about 30 volts, seven such plates in series would be necessary. Thus, the selenium stack would have a volume of about 150 cubic inches as compared to 2 cubic inches for the silicon unit—a space and weight saving of about 70-to-1.

Since each selenium plate has a forward drop of about 1.4 volts and seven series plates are required, the total forward drop of the selenium unit is 10 volts while that of the silicon is slightly less than 1 volt. As a consequence, the efficiency of the silicon cell is greater than 99 per cent as compared to only 95 for the selenium or, stated a different way, the losses for selenium are 5 times larger than for silicon.

An obvious advantage for military applications is the fact that silicon can be operated with only moderate deratings at ambients of 180 C while selenium is not dependable over 125 C at most. This high permissible cell temperature also has a very important significance in that air cooling may be used in nearly all instances thereby avoiding the complexities of water cooling.

At present, four voltage classifications are available: 50, 100, 150, and 200 volts. They have a forward current rating of 8 amperes with natural convection cooling in ambient air at 25 C. Higher current ratings up to 40 amperes can be achieved with forced cooling.

Present applications of these diodes include such diverse fields as magnetic amplifiers, rotating rectifiers on the shafts of brushless generators, welders, plating lines, power packs, etc. Similar diodes having ratings of hundreds of amperes will be available in the near future to fill a multitude of new industrial requirements in our presently expanding economy.

Construction of Undersea Cables Planned by Telephone Company

A location near Port Angeles, Wash., has been selected as the United States landing site for the American Telephone and Telegraph Company's underwater telephone cable to Alaska. The Long Lines Department of the company, which will construct the new communications route, applied to the state of Wash. in August for a permit to place the cable in the Strait of Juan de Fuca, off Port Angeles.

The submarine cable will extend from Port Angeles to Ketchikan, Alaska, where it will interconnect with a submarine cable between Ketchikan and Skagway, which is now being constructed by the Alaska Communications System, a division of the Army Signal Corps. The over-all cable system will link the telephone network of the Alaska Communications System (ACS) with the United States network of the Bell System. The entire project is expected to be in service by late 1956.

At present, telephone service between Alaska and the United States is provided by ACS over several radio and land line circuits. When completed, the new cable system will provide a short, direct route between the United States and Alaska. The cable system will be more reliable than existing facilities in that it will not be subject to damage from storms and the elements. With its capacity of 36 message circuits, the new cable system will be an important supplement for both public and defense purposes to the facilities now in use.

At Port Angeles, the cable is to be linked to Seattle with a radio relay system owned jointly by the Long Lines Department and the Pacific Telephone and Telegraph Company. At Seattle the circuits will be connected through the facilities of the latter company to the United States telephone network.

The 640-mile Bell System segment of the system will consist of twin deep-sea cables, similar in design and construction to those now being placed across the Atlantic between Newfoundland and Scotland. The cables will be laid several miles apart—one for northbound and the other for southbound transmission. The twin cables contain a single wire conductor wrapped with copper tapes and insulated with polyethylene, and are also protected by wrappings of jute and armoring wire. The deep sea portions measure $1^1/_4$ inches in diameter and the shore ends $2^9/_8$ inches.

The Port Angeles-Ketchikan cables also contain built-in amplifiers, spaced about 40 miles apart. The repeaters are the key to the cable system. Over 25 years of research by Bell Laboratories engineers were devoted to perfecting them. Each repeater employs three vacuum tubes housed in a flexible copper tube about 7 feet long and $1^3/_4$ inches in diameter. The tube is surrounded by steel rings to form a structure that is built into the cable. Thus, the repeater, which appears as a long tapering bulge in the cable, can pass easily through a cable ship's laying gear and assures an orderly and uninterrupted laying operation.

Plan U. S.-Hawaiian Cable System

The American Telephone and Telegraph Company and the Hawaiian Telephone Company recently announced plans for a submarine cable communications system connecting the United States mainland and the Hawaiian Islands to be ready for service early in 1958. Applications have been submitted for the necessary Governmental approvals.

The repeatered, twin-cable system will have practically the same design as that of the transatlantic cable now being constructed and of the cable to be laid in 1956 between Ketchikan, Alaska and Port Angeles, Wash. near Seattle. Engineering work on the Hawaiian project will get under way immediately. To meet the 1958 completion schedule it will be necessary to start some of the manufacturing operations shortly.

Present telephone service between Hawaii and the mainland is furnished jointly by the American and Hawaiian companies by means of radio circuits. The demand for service is expanding rapidly making it necessary to supplement existing facilities. The companies believe that the best way to do this is by cable rather than by additional radio installations. The radio spectrum is becoming crowded and future growth by this medium is necessarily limited. Also, continuity of service is more definitely assured when two means of transmission, radio and cable, are available.

New Formulas Permit Speedier Design of Optical Lenses

The first complete analysis of an optical image, a technique that will permit speedier design of better lenses, has been achieved in the Kodak Research Laboratories through the invention of new mathematical formulas. The new method was formulated by Dr. Max Herzberger, who heads Kodak's optical research in the laboratories' physics division.

The scientific short-cut is essentially a way of analyzing the optical image and considering it as a superimposition of five simple types of images. Dr. Herzberger did this by finding five simple types of image errors, from which he synthesized the most complex optical image. As part of his research, he also simplified a practical system of tracing skew or slanting rays of light through a lens so it could be used in routine calculations.

Until now, lens designers, using computing

machines, have laboriously traced rays of light through a lens system during the design stage. Dr. Herzberger has reduced this to the tracing of only nine rays, yet by projection with mathematics, this is equivalent to tracing perhaps 1,000 rays. Also, with his new technique, the entire area of the lens can be computed. Previously lens designers traced light only through a cross section of a lens system.

To achieve his complete analysis, he first learned how to classify image errors for full aperture and for an extended field. The types of errors describe the degrees of symmetery or asymmetery in the image. They also describe the amount of deviation in all directions. The method permits the designer to visualize how the errors are balanced in a given system and thus guides the designer in his aim to obtain a better lens.

The reliability of the new method was checked by use of microphotographs of tiny points of light as affected by various degrees of the five kinds of errors. The tiny photos prove the accuracy of the mathematics for cancelling out and combining for the best image.

New Tape Storage System for Railroad Automatic Classification

A new automatic Teletype tape storage system is in service at the Portsmouth Coal Yard on the Norfolk and Western Railway. With this new system which stores switching information for a complete train, all cars in a train can be classified and routed to desired tracks in the yard without the necessity for the operator to push a single button. Switches required to route each car to its designated track, position automatically as the car advances.

Developed by Union Switch and Signal, Division of Westinghouse Air Brake Company, the new system promises to be a significant contribution not only to railroad freight operations, but also to a variety of automation procedures in other industries.

This automatic classification is accomplished in the following manner. A perforated tape, containing destination track information for a whole train, is prepared automatically in the process of making up the cut list for the train. As such a cut list is being typed in the yardmaster's office, for example, a copy of the list is automatically typed in the control tower on a Teletype receiver. Simultaneously a reperforator is controlled to make the tape. When inserted in a transmitter distributor, this tape feeds the destination of each cut into the automatic switching system which then sets up the required route automatically.

In case of last minute changes, the operator actuates a cancellation button which cancels the existing storage and stops the operation of the transmitter distributor. After inserting a new destination by means of a route push button, the operator pushes a tape starting button to resume automatic operation. The system can be arranged so that a car can be rerouted to a specific track, say a bad-order track, by pushing only one button.

The system is designed to only accept numbers and the letter "X" as expressed in standard teletypewriter code. Other characters are rejected.

A combination of "XX" is used to cancel a number typed erroneously in the preparation of the cut list. By typing "XX" beside or below the incorrect number, it is possible to cancel a typographical error without retyping the entire list.

Each code must consist of two digits, or it will be automatically rejected. Thus, the code for track 2 would be type "02." If incorrectly typed with only one digit, it would automatically be rejected, and hence it would not be necessary to type "XX" beside or below the single digit.

The tape storage feeding system can be applied to an existing automatic switching system. The additional apparatus required consists of a reperforator, a Teletype transmitter distributor, a decoding unit, and two push buttons on the control machine.

Signatures Checked in Drive-In Bank by "TV Eye"

Indicative of the growing use of closed-circuit television as a medium for speedier service, an RCA "TV-Eye" system has been installed by the drive-in branch of the Delaware County National Bank, Chester, Pa., for quick, remote confirmation of check signatures.

The closed-circuit television system links two drive-in teller booths with the central signature department in the main bank building located across the street, according to Earl Harvey, manager of this new drive-in facility.

The compact "TV Eye" camera, which weighs less than 5 pounds, is installed in the signature room, and is connected by closed-circuit with a television receiver in each of the two drive-in booths. When withdrawal checks are presented the teller, without leaving his booth, confirms the signature by requesting the records department by intercom to flash the appropriate signature card on the television receiver. The "TV-Eye" system speeds the withdrawal procedure and eliminates traffic jams in the driveways.

Partial Schedule of Courses for Radioisotope Study

The special training division of the Oak Ridge Institute of Nuclear Studies has announced a partial schedule of courses to be offered during the next 12 months.

The Institute, a nonprofit educational corporation of 32 southern universities, conducts 4-week courses in the basic techniques of using radioisotopes in general research work, and special and advanced courses of varying duration which stress applications of radioisotopes in specific fields of scientific endeavor.

The following basic courses, which are limited to 32 participants, will be held during 1956:

48th	January 9–February 3
49th	February 6–March 2
50th	April 16–May 11
51st	June 4–29
52nd	July 16–August 10
53rd	August 13–September 7

The Institute's basic courses are designed to assist mature scientific and technical personnel in obtaining in a short time sufficient facility in the use of radioisotopes to utilize them safely and efficiently in their own research work. Minimum scholastic requirement for enrollment is a bachelor's degree, preferably in a scientific field, although no specific courses are required as prerequisites. Tuition for the basic course is $25.

Application blanks and further information may be obtained by writing Dr. Ralph T. Overman, chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn. Applications and supporting letters should reach the Institute 3 months in advance of the starting dates of the course for which application is made.

Hannibal C. Ford Fellowship for Advanced Study in Engineering

The Hannibal C. Ford Fellowship for advanced study in the Graduate School at Cornell University has been established by the Ford Instrument Company to provide an annual fund to enable an outstanding graduate from an engineering college to pursue full-time study in mechanical engineering, electrical engineering, engineering physics, or mechanics and materials to proceed toward a higher degree. The $4,000 Fellowship will pay the university expenses for tuition, fees, and similar cost and give the recipient a cash stipend of $2,500. He will have complete freedom of investigation into any branch of these fields of study in the Graduate School of Cornell. It is hoped by this Fellowship to encourage, in the first year of study at graduate level, talents and abilities in original scientific work so well exemplified by Hannibal C. Ford, Cornell, 1903, inventor, scientist, designer and electro-mechanical engineer, one of the nation's pioneers in the development of ordnance and navigational controls and computers, and founder of the company which bears his name.

Applicants for the Fellowship should write to the Dean of the Graduate School, Cornell University, Ithaca, N. Y., for application forms and full instructions as to what information the University requires concerning their qualifications. Candidates for the 1956 award will file their applications with the University prior to February 19, 1956.

AEC Selects Site for New Office Building

The selection of a site for a new headquarters building for the U. S. Atomic Energy Commission (AEC) near Germantown, Md., 23 miles from Washington was announced. The exact boundaries of the site will be determined after completion of detailed engineering surveys.

The site for the AEC office building was selected on the basis of site studies conducted by the Office of the Chief of Engineers at the Commission's request. Site studies began in early May and more than 50 sites within a radius of 20-to-30 miles of the Washington

Monument were considered. The major criteria used in making the selection included availability of an adequate water supply, extent of supporting community facilities, accessibility to Washington for business and commuting purposes, availability of a labor market and factors affecting the economy of construction and operation. It was determined that the location and the type of building to be constructed should afford reasonable protection against blast effects of a thermonuclear weapon in the event of attack on Washington, and also permit quick access to the Congress and the Executive Branch of the Government.

The cost of the project is estimated to be about $10,000,000. The final design of the building has not been determined, but it probably will be a three-story reinforced concrete structure. At least 50 acres will be required for the site.

The construction contractor will be selected on the basis of competitive bids and work is expected to start in the early spring of 1956, with completion of the building in the fall of 1957. In addition to the office building there will be a parking area for 700 automobiles, and a garage and maintenance building.

Dr. Bugher Recipient of AEC Awards

Dr. John C. Bugher, retired director of the division of biology and medicine of the U.S. Atomic Energy Commission (AEC), was presented the AEC Distinguished Service Award and the Superior Accomplishment Award, the latter carrying a cash value of $2,000.

Lewis L. Strauss, chairman of the Commission, presented the awards to Dr. Bugher on behalf of the Commission. Citations accompanying the awards praised his "outstanding service to the AEC in directing the activities of the division of biology and medicine."

Dr. Bugher rendered service to the AEC when he carried the responsibility of protecting the health of employees and the public during AEC operations. He early foresaw the potentialities in the use of atomic reactors for medical research and therapy, and played an important role in the authorization of the United States' first two medical reactors, now scheduled for construction.

Dr. Bugher has left the Commission, effective September 30, to return to the Rockefeller Foundation, from which he has been on leave since his entry into the atomic energy program in 1951. The Foundation recently announced his appointment as director, medical education and public health.

Bell Telephone Laboratories to Expand Murray Hill Facilities

Bell Telephone Laboratories has announced that it plans to construct an office building to provide about 105,000 square feet of additional working space at its Murray Hill location near Summit, N. J.

Although plans are not yet drawn, the building will probably consist of four stories and will be located adjacent to the rear of the original laboratory, opened in 1942, with which it will be connected.

The space in both main buildings, vacated by those who move to the new office building, will then be available for additional personnel requiring either laboratory or office space contiguous to laboratory space.

Expanded restaurant facilities are also scheduled for the Murray Hill laboratory. Seating space in the cafeteria will be enlarged by construction of a small addition which will occupy a portion of the inner court adjacent to the present cafeteria.

The new office building will be designed and constructed by Western Electric Company, manufacturing and supply unit of the Bell System, with basic requirements to be laid down by Bell Laboratories as owner. Design work is expected to start immediately. Tentative plans call for a flat-roof brick building whose general appearance will blend harmoniously with the present buildings.

Construction will be on a modular basis, providing the distinctive "flexible space" feature typical at Murray Hill. Occupancy of the new building is expected to begin in the spring of 1957.

Naval Architect First Recipient of Sperry Award

William Francis Gibbs, naval architect and marine engineer, has been selected as first recipient of the new Elmer A. Sperry Award for distinguished engineering contributions to the world's art of transportation.

Presentation of the international award will take place at Chicago, November 17th, during the Diamond Jubilee Anniversary Meeting of the American Society of Mechanical Engineers (ASME). The board chairman, Robert B. Lea, said Mr. Gibbs is honored for his many and continuing contributions to progress in sea transportation, including new ship design concepts, techniques, and judicious use of materials as combined in the *SS United States*. Other contributions include advocacy and application of light, compact, high-pressure and high-temperature marine power plants of greater efficiency and economy, with novel feed systems, heat balances, and high-speed gearing.

The award commemorates the interest and achievements in transportation of the late Dr. Elmer A. Sperry, whose wide range of inventions and patents included gyroscopic devices widely used on ships and aircraft. Established by Dr. Sperry's daughter, Helen, now Mrs. Lea, and son, Elmer A. Jr., the award has been made available for presentation annually to an individual or group of any nationality selected by the awards board. The board is comprised of representatives of four technical societies in which Dr. Sperry held office or membership—ASME, of which he was 48th president; AIEE, of which he was a founder; the Society of Automotive Engineers (SAE), and the Society of Naval Architects and Marine Engineers (SNA&ME).

Consisting of a bronze medal, certificate, honorarium and copy of Jerome C. Hunsaker's biography of Dr. Sperry, the award recognizes distinguished engineering contributions which not only have advanced the art of transportation by land, sea, or air, but have proved in use to be of practical and continuing benefit to mankind.

NSPE Booklet Available on Conference Proceedings

A complete transcript of the recent conference in Philadelphia, Pa. on professional development sponsored by the National Society of Professional Engineers has been published in booklet form.

The conference on "Professional Development—The Responsibility of Industry and the Engineer" featured talks and panel discussions held in conjunction with the 21st Annual Meeting of the national society, June 2–4.

The 56-page booklet covers the entire proceedings of the conference from the opening of the sessions by Clarence T. Shoch, retiring president of the national society, to a final question and answer period. The booklet is available at $4 from the National Society of Professional Engineers, 1121 15th St., N.W., Washington 5, D. C.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Wire

To the Editor:

The writer has uncovered a controversial point in reference to the most common of all electrical items—namely "wire."

The controversy concerns the word "wire" itself. It seems more than just a bare possibility that the four symbols originating in the early electrical arts as "W" for watts, "I" for current, "R" for resistance, and "E" for voltage or potential also are the same four letters forming the word "wire."

All reference works seem to agree on the definition of a wire, and describe it physically, with mention dating to about the fifteenth century.

No mention has been found that indicates

that the word was formed by combining the symbols or that the electrical symbols came from the word "wire."

J. B. WINTHER (M'47)

(Alectric Manufacturing Company, Kenosha, Wis.)

Answer to "Short Circuit Analysis"

To the Editor:

Referring to the discussion of my paper, "Power System Fault Current Analysis Including Study of Transient Offset," by Mr. W. A. Tripp in "Letters to the Editor" in the July issue of *Electrical Engineering*, the omission of the words "increase" and "theoretical" would have been more correct for the intended practical presentation of the subject.

Mr. Tripp refers to the offset curves as an experimental probability study for the case of zero load current. I believe it should better be called a statistical summarization of factual results of system tests. True, the values of prefault load currents affect the degree of maximum offset, but based on the current carrying capacity and the maximum interrupting capacity of a modern high-voltage line circuit breaker, which would be the maximum probable load current value, the approximate maximum effect of full load current through the test breaker would be in the order of three to five per cent, which is negligible from a practical point of view. For our purpose the offset data without random load currents is more desirable. The minor effect of load current can be added if desired.

The purpose of the paper was to relate from a practical viewpoint our experience with offset currents resulting from extensive tests without delving into the theoretical and infrequent exceptions. It is well, however, to have these exceptions pointed out so that one may be aware of their possibility for special cases.

A subsequent paper is soon being offered for presentation, again with the practical approach, to show approximate methods for predicting maximum offsets and rates of decay of fault currents on a high-voltage power transmission system.

MARTIN J. LANTZ (M'51)

(Bonneville Power Administration)

NEW BOOKS . . . . .

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

SOCIETY OF PLASTICS ENGINEERS. Papers presented at 11th Annual National Technical Conference, Atlantic City, N. J., January 1955. (An official publication of the society, volume I). Available from Society of Plastics Engineers, 34 East Putnam Avenue, Greenwich, Conn., 530 pages, 8½ by 5½ inches, paper. $7.50. The subjects treated in the 50 papers included cover a wide range of subjects in plastics engineering —properties, design, molding, fabricating, and applications of many types of plastics. Representative papers deal with sandwich panels, laminates for printed circuits, plastics pipe, plastics in the atomic energy program, and engineering applications of silicone rubber.

PROTECTIVE CURRENT TRANSFORMERS AND CIRCUITS. By P. Mathews. 1955, Chapman and Hall Ltd., London, England, 253 pages, 8½ by 5½ inches, bound. 36s. A definitive treatment of the subject which includes applications to practical problems as well as laying the theoretical groundwork. Part I covers the theoretical aspects of steady-state conditions, general design considerations, and certain special applications. Part II deals with transient currents and with ferromagnetic effects in protective systems.

ADVANCED CALCULUS. By Louis Brand. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1955. 574 pages, 9¼ by 6 inches, bound. $8.50. This is a systematic treatment covering the subject from the system of real and complex numbers to the functions of the real and complex variable. Important classes of functions (continuous, differentiable, integrable, of bounded variation) are thoroughly treated, and separate chapters are devoted to reversal of order in limiting processes and to Fourier series.

THE A.R.R.L. ANTENNA BOOK. American Radio Relay League, Inc., West Hartford, Conn., seventh edition, 1955. 306 pages, 9½ by 6½ inches, paper. $2. Intended for reference use or as a training text, this book deals with principles of antennas and transmission lines, wave propagation as related to antenna design, and performance characteristics of directive antenna systems. It also includes complete data on specific designs for the various amateur bands, and a number of chapters on mechanical features of construction and related subjects.

APPROXIMATIONS FOR DIGITAL COMPUTERS. By Cecil Hastings, Jr. Princeton University Press, Princeton, N. J., 1955. 201 pages, 9½ by 6¼ inches, bound. $4. "This monograph deals with the subject of best approximation in the sense of Chebyshev as applied to the problem of making univariate functional data available to the high-speed digital computing machine." (Preface) It includes 74 approximations, each with a carefully drawn error curve, and an introduction dealing with the use and construction of such approximations.

BASIC PROCESSES OF GASEOUS ELECTRONICS. By Leonard B. Loeb. University of California Press, Berkeley 4, Calif., 1955. 1,012 pages, 9½ by 6¼ inches, bound. $13.50. This extensive monograph treats in detail the following subjects: ionic mobilities, diffusion of carriers in gases, distribution of energy of electrons in a field, velocities of electrons in gases, formation of negative ions, electrical conduction in gases, ionization by collision of electrons (the first Townsend coefficient), and the second Townsend coefficient. For the benefit of engineers and others new to the field, a simplified phenomenological or kinetic-theoretical introduction to each topic precedes the more advanced material.

BESSEL FUNCTIONS FOR ENGINEERS. By N. W. McLachlan. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y., second edition, 1955. 239 pages, 9½ by 6¼ inches, bound. $5.60. Intended for all students of applied mathematics, this book sets out the theory in logical sequence and provides worked examples illustrating a wide range of analytical processes and applications: Water-waves, flexible membranes, loud-speaker horns, electrical transmission lines, bars and plates, eddy-current heating, heat diffusion in engine cylinders, etc. The book has been considerably revised from the earlier edition.

CASE STUDIES IN INDUSTRIAL MANAGEMENT. By J. M. Juran and Norman N. Barish. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1955. Various paging, 11½ by 9¼ inches, spiral binding. $5. Each of the 16 studies included deals with a separate phase of the operation of a single company. The Burndy Engineering Company: financing, organization, product development, plant location manufacturing planning, plant layout, plant maintenance, etc. Intended as a laboratory manual for students of industrial management, the book is fully illustrated with photographs, diagrams, and reproductions of actual business papers.

THE COMMISSIONING OF ELECTRICAL PLANT AND ASSOCIATED PROBLEMS. (Monographs on Electrical Engineering, Volume V) By R. C. H. Richardson. Chapman and Hall Ltd., London, England, third edition, 1955. 440 pages, 8¼ by 5½ inches, bound. 50s. This thoroughly revised edition, presents information that has been found useful in putting new plants into operation. The various sections of the book cover alternators, a-c motors, transformers, d-c generators and motors, rotary converters, mercury-arc rectifiers, and circuit breakers. A bibliography is included.

CONDUCTION HEAT TRANSFER. By P. J. Schneider. Addison-Wesley Publishing Company, Inc., 500 Kendall Square Building, Cambridge 42, Mass., 1955. 395 pages, 9½ by 6¼ inches, bound. $10. This text, designed mainly for use in a graduate-level course, treats a variety of familiar engineering systems—steady one-dimensional, steady heat-source, transient, etc.—using four methods of approach: analytical, graphical, numerical, and experimental. In order to prepare the student for the main body of material, chapters are included on Bessel and Legendre differential equations and on Fourier series and integrals.

COORDINATION, CONTROL, AND FINANCING OF INDUSTRIAL RESEARCH. Edited by Albert H. Rubenstein. King's Crown Press, Columbia University, 2960 Broadway, New York 27, N. Y., 1955. 429 pages, 8½ by 5¼ inches, bound. $8.50. This volume constitutes the Proceedings of the Fifth Annual Conference on Industrial Research with some selected papers from the fourth conference. A wide range of topics is covered by authorities both from top management positions in industry and from university staffs. Abridged notes of the clinic sessions are included, as well as the formal papers.

DEFECTS IN CRYSTALLINE SOLIDS. The Physical Society, London, England, 1955. 429 pages, 10¼ by 7 inches, paper. £2. This report includes over 45 papers of which many are concerned with the use of magnetic resonance methods for the investigation of dislocations and point defects such as F-centers. Other papers deal with the influence of these defects on the structural and mechanical properties of a wide range of solids.

FALTWERKE. By Joachim Born. Konrad Wittwer, Stuttgart, Germany, 1954. 204 pages, 9½ by 6½ inches, bound. DM 21. A detailed treatment of the theory and structural analysis of prismatic and pyramidal structures, i.e. structures composed of flat planes or panels. A considerable variety of forms and sizes are dealt with and certain special aspects are considered, for example, the buckling of such structures or structural elements.

HOW TO TRAIN ENGINEERS IN INDUSTRY. (Executive Research Survey, No. 4) National Society of Professional Engineers, 1121 15th Street, N. W., Washington 5, D. C., 1955. 72 pages, 9 by 6 inches, paper. $2. An analysis of the experience of more than 200 companies and the opinions of many individual leaders in the training field. It covers, among other things, typical training programs, how to train the "trainers," and guidance toward professionalism.

INDUSTRIAL VENTILATION. A Manual of Recommended Practice. American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, P. O. Box 453, Lansing, Mich., 1954. Various paging, 11 by 8½ inches, spiral binding. $3. The purpose of this manual is to meet the needs of official industrial hygiene agencies for a ready single source of recent data on industrial exhaust ventilation, for standardizing ventilation practices, and for training purposes. The many sketches, graphs, and data tables make the manual useful for anyone, such as the plant engineer, who must deal with ventilation problems.

INFORMATION PROCESSING EQUIPMENT. Edited by M. P. Dom. Reinhold Publishing Corporation, 430 Park Avenue, New York, N. Y., 1955. 270 pages, 9½ by 6 inches, bound, $8.75. This book describes a wide variety of commercially available equipment for the preparation and reproduction of reports and for the recording and handling of information: automatic typewriters, stencil-producing machines, microfilm cameras and readers, equipment for dry photographic copying, dictating machines, punched cards, calculators, computers, etc. Lists of manufacturers and suppliers are included.

LIGNES ELECTRIQUES T.H.T. By H. Carpentier. Éditions Eyrolles, Paris, France, 1955. 250 pages, 9½ by 6¼ inches, bound. Ffr.4800. A practical treatise on high-tension line design and construction which covers cable calculations, insulators, tower construction and

erection, foundations, etc. Project planning, lightning protection and important economic aspects are also discussed. A useful feature of the book is the group of detailed design procedures for actual installations, together with practical methods of construction.

MAGNETIC ALLOYS AND FERRITES. Edited by M. G. Say. George Newnes Ltd., London, England, 1954. 200 pages, 8½ by 5½ inches, bound 21s. This book deals with the properties and applications in electrical engineering of soft magnetic materials, permanent magnet steels and alloys, permanent magnet ferrites, and magnetic powder cores. The related subjects of materials for magnetic recording and magnetostriction, and nonmagnetic ferrous and magnetic compensating alloys are also treated, and an introductory chapter briefly reviews modern ferromagnetic theory.

MATERIALS FOR NUCLEAR POWER REACTORS. By Henry H. Hausner and Stanley B. Roboff. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y., 1955. 224 pages, 7 by 4¾ inches, bound. $3.50. This is another in a series of concise summaries of essential information on new developments in various fields of science and technology. The present volume deals with criteria for selecting materials for shielding, for cladding of fuel elements, for moderators and reflectors, and for most of the important parts of a reactor. The material is presented in a form understandable to the layman with some technical background.

MECÁNIQUE VIBRATOIRE. By Robert Mazet. Librairie Polytechnique Ch. Béranger, Paris, France, 1955. 280 pages, 9½ by 6¼ inches, bound. Ffr.4975. Beginning with the fundamentals of vibrating systems, this text continues with analytical discussion of the dynamics of various characteristic systems. Analogies are pointed out among the phenomena of several branches of physics—mechanical, electrical, acoustical, etc. The aerodynamic aspects of vibration, such as flutter, are given particular attention.

METALS REFERENCE BOOK. By Colin J. Smithells. Interscience Publishers Inc., 250 Fifth Avenue, New York 1, N. Y., second edition, 1955. Two volumes, 10 by 6¾ inches, bound. $25./set. A convenient and comprehensive summary of a wide range of physical, mechanical, and electrical data relating to metallurgy and metal physics. In this new edition, new values have been substituted where more recent and reliable information has become available, several sections have been rewritten and new sections have been added covering elastic properties and damping capacity physical properties of molten salts, and friction. The presentation is largely in tabular form, with brief monographs included where information could not otherwise be adequately given.

NOTES & FORMULES DE L'INGÉNIEUR. Albin Michel, Éditeur, Paris, France, twenty-third edition, 1938–1955. Four volumes, 7½ by 5 inches, bound. Ffr.16,252./set. Some 7,500 pages in four volumes provide an extensive compilation of data for engineers of all kinds. The respective volumes cover the following topics: 1. mathematics, mechanics, hydraulics, heat and heating, steam power; 2. fluid mechanics, refrigeration, metallurgy, mining, gas plants, railroads, highways, internal-combustion engines, hoisting equipment; 3. motor vehicles, aerodynamics and airplanes, general electricity; 4. electrical engineering, telecommunications, electronics, electric traction. Some special topics such as the preparation of manuscripts are also included.

PROCEEDINGS OF THE EIGHTH ANNUAL CONFERENCE ON THE ADMINISTRATION OF RESEARCH, 1954. New York University Press, Washington Square, New York 3, N. Y., 1955. 108 pages, 11 by 8⅓ inches, paper. $4. The conference papers are devoted to various aspects of the following broad subjects: appraising and rewarding the researcher's output, management in the research laboratory, communication problems, physical facilities, and basic research in an applied research laboratory. Some of the specific topics of the 24 papers are merit raises, qualifications of an engineering manager, communication with management, designing buildings for research, and the use of consultants.

PROCEEDINGS OF THE SIXTH BRITISH ELECTRICAL POWER CONVENTION, 1954. British Electrical Power Convention, London, W. 1, England, 1954. 500 pages, 8¾ by 5⅔ inches, bound. 12s.6d. The five technical papers included are relatively extended treatments, with discussion, of the following topics: electrical engineering in world trade; modern commercial, industrial and domestic lighting practice; electricity in the home; the development of domestic electricity load in Britain and in other countries; and installation practices in a number of countries.

PROGRESS IN LOW TEMPERATURE PHYSICS. Volume I. By C. J. Gorter. Interscience Publishers Inc., 250 Fifth Avenue, New York 1, N. Y., 1955. 418 pages, 9 by 6¼ inches, bound. $8.75. Eighteen papers by research specialists present concise surveys of various aspects of the three main fields involved—magnetism, properties of liquid helium, and superconductivity—and in addition, such allied topics as the electronic specific heat in metals, velocity and absorption of sound in condensed gases, and transport phenomena in gases. There is a combined subject index and the author Index covers the extensive bibliographies.

SOLAR ENERGY RESEARCH. Edited by Farrington Daniels and John A. Duffie. University of Wisconsin Press, 811 State Street, Madison, Wis., 1955. 290 pages, 9½ by 6¼ inches, bound. $4. Based in part on a symposium held at the University of Wisconsin in 1953, this volume includes reports by 31 contributors on the present status of the utilization of solar energy. Space heating, power plants, large-scale furnaces, and a wide range of other uses of solar energy are discussed in the 11 sections into which the book is divided. A bibliography is included.

THEORY OF ALTERNATING-CURRENT MACHINERY. By Alexander S. Langsdorf. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., second edition, 1955. 666 pages, 9¾ by 6¼ inches, bound. $8.50. This standard text has now been revised in accordance with the current presentation of the subject. The comprehensive treatment covers all major types of a-c electrical machines, beginning with the transformer, and includes a new chapter on mercury-arc rectifiers and converters. A clear distinction is made between fundamental principles and the structural, design, and operational features. The rationalized meter-kilogram-second system of units is used throughout.

THE VIKING ROCKET STORY. By Milton W. Rosen, Harper and Brothers, 49 East 33d Street, New York 16, N. Y., 1955. 242 pages, 8¾ by 5¾ inches, bound. $3.75. An account of the development, construction, and launchings of a series of 10 Viking rockets which were designed primarily for the exploration of the upper atmosphere. The author, the scientific officer in charge of the project, has written in a dramatic style to convey to the reader the feelings and thoughts of men who worked on the rocket.

TRANSFORM CALCULUS with an Introduction to Complex Variables. By E. J. Scott. Harper and Brothers, 49 East 33d Street, New York 16, N. Y., 1955. 330 pages, 6¾ by 9 inches, bound. $7.50. Intended mainly for engineers and others interested in applications of mathematics, this text emphasizes the use of transforms in the solution of physical problems covering a considerable range of topics: vibration of rods, flutter, beam deflection, diffusion, networks, and transmission lines. The Laplace transform, as the most useful, receives the greatest attention, although other integral transforms are also considered.

VERÖFFENTLICHUNGEN DES DEUTSCHEN STAHLBAU—VERBANDES. 1/54: Korrosionsschutz in Stahlbau; 2/54: Gestalteter Stahl; 3/54: Ansprache und Vortrag; 4/54: Betrachtungen über Theorie und Anwendung von Verbundkonstruktionen; 5/54: Ergebnisse der Versuche und Messungen auf dem Gebiet der Verbundbauweise. Stahlbau-Verlag, Cologne, Germany, 1954. 76 pages, DM 7.50; 154 pages, DM 12.00; 24 pages, DM 3.00; 31 pages, DM 4.50; 71 pages, DM 7.50. 9½ by 6¾ inches, paper. These five contributions provide the following comprehensive reviews of methods for the protection of steel structures against corrosion, and of recent developments in their architectural treatment; a discussion of various open problems in statics not yet satisfactorily solved; and brief reviews of current research on, and applications of, composite structures of reinforced concrete and rolled steel sections.

ANALYSIS OF FEEDBACK CONTROL SYSTEMS. By Robert A. Bruns and Robert M. Saunders. 1955, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. 383 pages, 9¾ by 6¼ inches, bound. $7.50. The two major parts of this text deal respectively with servomechanism and regulator components, and with feedback-system theory. Basic physical laws are given for electrical, magnetic, mechanical, pneumatic, and hydraulic elements. These in turn are used as a foundation for the system analysis. The frequency-response approach is used throughout.

CHEMISTRY OF THE SOLID STATE. Edited by W. E. Garner. 1955, Academic Press, Inc., 125 East 23rd Street, New York 10, N. Y. 417 pages, 10 by 6¼ inches, bound. $8.80. The 15 chapters by various authorities which comprise this volume deal with such topics as dislocations and defects in crystals, semiconductivity and magnetochemistry of the solid state, kinetics of solid reactions, explosion and detonation of solids, oxidation of metals, catalysis, and the photographic process. The unified approach is essentially from the physical chemistry standpoint.

DIELECTRIC BEHAVIOR AND STRUCTURE. By Charles Phelps Smyth. 1955, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. 441 pages, 9¾ by 6¼, bound. $9. The early chapters of this monograph deal with the theory, experimental interpretation, and measurement of dielectric constant and loss. The determination of dipole moments is then discussed, with the later chapters giving detailed information on the moments of groups of similar compounds including the relation to molecular structure.

ELECTRO-TECHNOLOGY. Basic Theory and Circuit Calculations for Electrical Engineers. By M. G. Say. Philosophical Library, 15 East 40th Street, New York 16, N.Y., 1955. 167 pages, 8¾ by 5½ inches, bound. $6. This book presents, in concentrated form, the electrotechnical basis of the phenomena which are important in light and heavy electrical engineering. An introductory section deals with conduction, and with magnetic and electric field effects. The second part gives a complete guide to the handling of circuit problems. A feature of the book is the collection of network theorems for all types of circuits and networks.

FUNDAMENTALS OF FRICTION AND LUBRICATION IN ENGINEERING. American Society of Lubrication Engineers, 84 East Randolph Street, Chicago 1, Ill., 1954. 196 pages, 8½ by 5½ inches, paper. $3.50. The 12 papers presented in this first ASLE National Symposium cover many aspects from historical and general surveys of the hydrodynamics of lubrication to specialized treatments of various bearing types, the constitution of lubricants, friction problems, and wear.

DIE GRUNDLAGEN DER AKUSTIK. By E. Skudrzyk. Springer-Verlag, Vienna, Austria, 1954. 1084 pages, 9¾ by 6¾ inches, bound. $35. A comprehensive work on the whole field of acoustics which provides a thorough theoretical background, relates the theory to the practical applications, and surveys the present state of research. It is designed to be of use to the engineer and physicist as well as to the acoustics specialist. A bibliography of over 4,000 references is broadly classified according to the chapter subject matter.

HANDBOOK OF INDUSTRIAL ENGINEERING AND MANAGEMENT. Edited by W. G. Ireson and E. L. Grant. 1955, Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. 1203 pages, 9¾ by 6¼ inches, bound. $16. In addition to covering the traditional subjects such as time study, plant layout, etc., this new handbook contains sections on engineering economy, budgeting, standardization, safety engineering, industrial hygiene, quality control, industrial statistics, and operations research. Intended both as reference manual and text, the treatment stresses general principles and the best current practices.

LIGHT CALCULATIONS AND MEASUREMENTS. By H. A. E. Keitz. 1955, N. V. Philips Gloeilampenfabrieken, Eindhoven, Holland. 413 pages, 9¾ by 6¼ inches, bound. $7.50. Using a minimum of mathematics, this book for the practicing illuminating engineer explains the concepts underlying the diagrams and equations in common use, and described the devices and equipment used in photometry. Among the subjects discussed are luminous flux, light distribution, illumination calculations, visual and physical photometers and their uses, and the measurement of reflection, transmission, and absorption. Enough detail is given to enable the reader to devise measuring arrangements for special purposes.

MACHINE TRANSLATION OF LANGUAGES. Edited by William N. Locke and A. Donald Booth. Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N.Y., 1955. 243 pages, 9¾ by 6 inches, bound. $6. The 14 essays of which this book is composed deal with many aspects of the subject, from detailed treatments of the linguistic difficulties to the mechanical problems involved, such as the storage memory devices. The approach is essentially philological in character but some actual methods of mechanised translation are described as well as the results of one of the first practical experiments.

does the three big jobs high production strip mine

Imagine the worst possible environment for electrical cable, and you'll find it at the strip mine shown in these pictures. The operators are plagued with underground fires, so severe that they have ruined the plastic windows in some of the power shovels. The rocks get so hot that you can't touch them or walk on them.

Despite the heat, the Tiger Brand Amerclad cable lies on the ground day in and day out, delivering dependable power 21¾ hours every day.

They do a lot of blasting at this mine, too. Although they try to protect the cable, it is pounded by large, sharp rocks almost every time there is a blast. Yet, when the pictures were taken, all the original cable was still in use, after *12 solid years of service.*

The mine owners point out that when a cable fails it costs money in down-time and replacement. The clincher is this: every foot of shovel cable, welding cable and drilling cable in the mine is Tiger Brand Amerclad.

Roughhouse service. That cable slung in the air and coiled on the sides of the drills is all Tiger Brand Amerclad.

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This solenoid is designed to operate over a temperature range of −67° F to as high as a scorching 600° F, and over a voltage range of 14 to 30 volts d-c. Has a continuous life of 500 hours at 500° F, longer at lower ambients.

Special impregnation makes it unusually compact. Eliminated is the bulky insulation between turns common to other high-temperature units of this type. This impregnation also makes the coil impervious to salt spray and fungus. Design data includes:

Stroke	.156 inches
Coil Resistance	14.5 ohms @ −67° F
	21 ohms @ +70° F
	33 ohms @ +500° F
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Weight	0.7 pound
Operating Voltage	14 to 30 d-c

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JACK & HEINTZ
AIRCRAFT
Rotomotive EQUIPMENT

INDUSTRIAL NOTES ....

General Electric News. Electric locomotives with electronic tubes will be replacing the original split-phase electrics on tracks of The Virginian Railway Company. Together with the four 6,880-hp motor-generator locomotives built by General Electric in 1948, they will handle all traffic on the electrified section. The company has placed an order with G. E. to build 12 more 3,300 hp rectifier locomotives for The Virginian to be placed in use between Roanoke, Va., and Mullens, W. Va., a distance of 134 miles over mountainous territory. Power for the locomotives will be taken from an overhead wire, reduced in voltage by a transformer, and fed into 12 rectifier tubes which convert the alternating current to direct current for the traction motors.

On July 22, General Electric signed a contract with Commonwealth Edison, Chicago, Ill., to construct a 180,000-kw nuclear power plant, near Chicago. The project will be financed entirely with private funds, will be located on the Illinois waterway, 47 miles southwest of Chicago, and will be powered by a dual-cycle boiling water nuclear reactor. The power plant is scheduled for completion in 1960.

Propulsion equipment for the U. S. Navy's fifth attack-carrier of the Forrestal class will be built by the company. The equipment for the new carrier, designated the U.S.S. *Congress*, *CVA-63*, will be almost identical to the propulsion units General Electric has built and shipped for the U.S.S. *Saratoga*, *CVA 60*; and presently is building for the U.S.S. *Ranger*, *CVA 61*; and the U.S.S. *Independence CVA 62*.

For testing household refrigerators and freezers, rooms in which temperatures can be controlled over a 120 F range to within 1/2 F are being completed by the company at Appliance Park, Louisville, Ky. The humidity can be adjusted within three per cent in the rooms in which the most severe conditions of temperature and air-moisture are created. Performance of insulation and compressors is tested in the 20 rooms at temperatures from 0 to 120 F, and at humidities to 95 per cent.

Raytheon Builds Laboratory. Raytheon Manufacturing Company, Waltham, Mass. announced that it has established a laboratory at the White Sands Proving Grounds, Las Cruces, N. Mex. The laboratory will conduct tests and evaluate equipment which Raytheon is developing for U. S. Army Ordnance. A building on the base has been allocated to Raytheon, and the necessary equipment is being furnished by the electronics firm, and by the armed forces. The laboratory was set up by the Missile and Radar Division of Raytheon's equipment operations, and its functions are being integrated with the company's guided missile test facilities at Point Mugu, Calif.

ElectroData Moves into New Plant. ElectroData Corporation, manufacturer of Datatron electronic computers, has completed moving personnel and equipment into its new 40,000 square foot plant in Pasadena's Hastings Ranch section. This move brings together ElectroData operations which formerly occupied four separate locations in Pasadena, Calif.

IT and T Expands. The International Telephone and Telegraph Corporation (IT and T) plans to construct a new plant in Los Angeles, Calif., for the further expansion of manufacturing electronics equipment by one of its divisions, the Federal Telephone and Radio Company. At the new location electronic products are to be produced, including power supplies and other devices many of which are used in aircraft manufacture. Located in the northern San Fernando Valley, it will be situated on 13 acres, and is to be served by a Southern Pacific Railroad siding.

Budd Company to Produce Gamma Radiography Equipment. The Budd Company of Philadelphia, Pa., builders of automotive bodies and wheels, stainless steel railway passenger cars, and jet engine components, plans to manufacture, sell, and service gamma radiography equipment, and service units previously produced by The Gamma Corporation, Mansfield, Mass. Dr. A. J. Stevens, former president, C. F. Thompson, former vice-president, and T. W. Healy, former treasurer of The Gamma Corporation, have joined The Budd Company, and will continue their activities in connection with isotope radiography equipment, as well as other applications of nuclear radiation.

New Hermetic Seal Company Is Formed. A new hermetic seal manufacturing company, the Atmo Seal Company, has recently opened a plant in Cincinnati, Ohio. It will specialize in manufacturing fusion-sealed terminals for the electronic and refrigeration industries. The modern plant is equipped and staffed to produce hermetic seals for all types of electrical components. Atmo has developed and uses a special process of fusing glass to steel electrodes and headers to protect sensitive electrical parts.

Hudson Industrial Electronics in New Quarters. Spurred by increasing activity among its industrial patrons, Hudson Industrial Electronics Company, Inc., has moved its industrial sales operation to new quarters at 37 West 65th Street, New York, N. Y.

Braniff Gets Reservation "Brain." Braniff International Airways, Dallas, Tex., announced that an order has been placed for an electronic reservation "brain" that will keep track of seats on all flights throughout Braniff's entire system 31 days

in advance, and automatically notify the airline's sales agents throughout the system of the availability of seats. The special equipment will be designed, installed, and maintained by the Teleregister Corporation, Stamford, Conn., designers of reservations control systems. The electronic unit receives all messages transmitted by Teletype from all Braniff stations and sales offices, and automatically records sales, cancellations, and other information related to seat space. The equipment also electronically originates its own report to all Teletype networks when the space status of a flight is changed. The electronic unit is to be tied in with Braniff's communications network connecting 58 cities in the United States and, by radio and radio Teletype at Miami, Fla., the Latin-American cities served by Braniff. The system is designed to accommodate a considerable increase in passenger travel.

New Radiation Laboratory. Gulf Oil Corporation plans to build a nuclear science laboratory at the company's research center in Harmarville, Pa. Principal unit in the laboratory will be a giant three-million volt atom smasher which is being built by High Voltage Engineering Corporation, Cambridge, Mass. Known as a Van de Graaff particle accelerator, it is capable of producing virtually all the fundamental forms of radiation in powerful streams of electrons, x rays, positive ions or neutrons.

General Cable to Manufacture in Florida. General Cable Corporation, New York, N. Y., plans to construct a modern manufacturing plant in Tampa, Fla., where it already operates a warehouse and sales office. The unit will have modern equipment for the manufacture of paper telephone cables and other wires and cables for the growing requirements of the Peninsular Telephone Company, the Inter County Telephone and Telegraph Company, the Southeastern Telephone Company, and other expanding telephone companies operating in the Southeast.

TelAutograph Executive Named. David M. Goodman has been appointed assistant chief executive officer for TelAutograph Corp. The addition of Mr. Goodman to the staff is a part of the program to expand the electronics and nucleonics research and manufacturing program of the company. Mr. Goodman has held major administrative positions at both Magnavox Research Laboratories and Hughes Aircraft Company. In his new position, Mr. Goodman will direct the expansion program of TelAutograph Corporation, and the moving of its executive offices from their New York, N. Y., location to Los Angeles, Calif.

RCA Awarded Government Contract. The nation's first installation of compatible color television for hospital use will be made by Radio Corporation of America to serve three Governmental medical activities located at Walter Reed Army Medical Center, Washington, D. C. The comprehensive installation will provide three complete color television systems for use by the Armed Forces Institute of Pathology, the Walter Reed Army Hospital, and the Army Medical Service Graduate School. The installation represents the largest compatible color television system so far developed for nonentertainment applications.

Southwest Research Changes. Southwest Research Institute, San Antonio, Tex., has announced the appointment of S. H. Simpson, Jr., former manager of communications research, to assistant vice-president concentrating on co-ordination of the Institute's research program for industry, business, and the military services. The creation of a new electrical engineering department, which will assume responsibility for certain research areas formerly included within the research organization's physics department was also announced.

Solar Battery Furnishes Power. The Bell solar battery has been placed in service in an experiment near Americus, Ga., to furnish electric power to a new rural telephone system using transistors instead of vacuum tubes. The experiments are being conducted jointly by the Bell Telephone Laboratories and Southern Bell Telephone and Telegraph Company.

Research Center Planned. Plans have been made for the construction, in Des Plaines, Ill., of a multimillion-dollar Borg-Warner Research Center. Construction of the first laboratory unit of the research center has been started on a 36½-acre site and will contain facilities for metallurgical, electronic, electrical, chemical, acoustical, hydraulic, applied mechanical, physics, and nuclear research. The laboratory also will house a complete machine and model shop, a modern computation center, and a large technical reference library. About 100 scientists and engineers will be engaged at the start of the operation. The Des Plaines research center will replace the smaller Borg-Warner Central Research Laboratory now operated at 706 South Twenty-fifth Avenue in Bellwood, Ill.

Private Firm to Produce Radioisotopes. Nuclear Science and Engineering Corporation, Pittsburgh, Pa., has begun production of radioisotopes in cyclotrons, supplying them to industrial and medical users. For the past six years, the only United States supplier of cyclotron-produced radioisotopes has been the Atomic Energy Commission. The corporation will produce, on request, any isotope which can be made with a cyclotron, and in addition, long-lived isotopes which may be in great demand will be stockpiled.

Vice-President Elected. Gordon Dean, former chairman of the United States Atomic Energy Commission, has been elected senior vice president—nuclear energy of General Dynamics Corporation. Mr. Dean, who has been a member of Dynamics' board since July 1954, will coordinate the widespread atomic energy activities of the corporation in his new assignment. One of the main objectives of the new facilities will be to bring down reactor costs through simplified design, and increased efficiency.

(*Continued on page 22A*)

NEW TYPE OVERVOLTAGE RELAY

Unaffected by environment... needs no rectifier

Easy adjustment to desired voltage limits, long life, reliability and simplicity are other features incorporated in this J&H overvoltage relay for aircraft. While designed primarily for J&H a-c control panels, it works equally well on any a-c system or control panel.

This "glow switch" relay offers the following improvements over present overvoltage relay circuitry:

- Calibrations unaffected by mounting position, altitude, or acceleration in any direction.
- Hermetic sealing prevents damage from humidity, fungus, dust and salt spray.
- A-c power is sensed direct; relay needs no rectifiers.
- Low stand-by power drain.
- Adjustable minimum trip voltage and time delay.
- Smaller and lighter over-all circuit.

For complete details, write Jack & Heintz, Inc., 17622 Broadway, Cleveland 1, Ohio. Export Dept., 13 E. 40th St., New York 16, N.Y.

© 1955 by Jack & Heintz, Inc.

JACK & HEINTZ Rotomotive AIRCRAFT EQUIPMENT

International Rectifier Corporation

proudly presents

International germanium power rectifiers!

This new line of Power Rectifiers features:

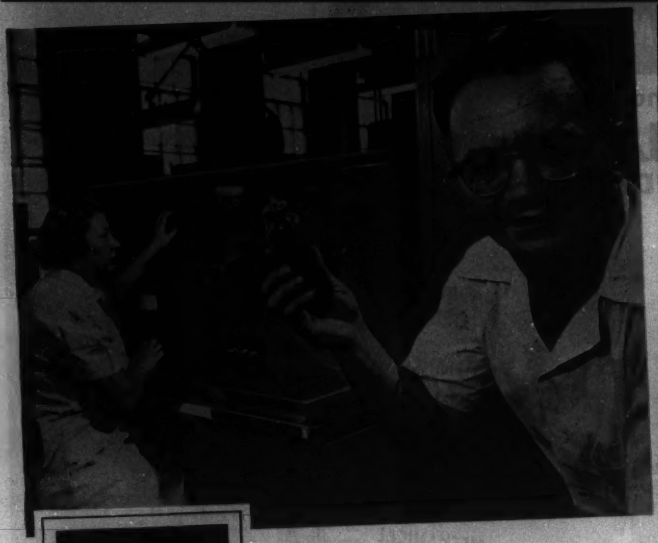
- High efficiency — up to 97%
- Lowest forward drop
- High reverse to forward ratio
- No reforming required after storage
- Unlimited life expectancy
- Ratings:
  26 to 66 AC input volts per junction
  150 to 100,000 amps DC output

Operating temperature range:
-55° C to +75° C

International Rectifier

CORPORATION

America's Most Complete Line of Instrument Calibration Standards!



"Simple to Operate.. yet EXTREMELY ACCURATE"

FROM ACTUAL EXPERIENCE BY
Test Engineering Activity
RCA TUBE DIVISION
HARRISON, NEW JERSEY

For three years the life test laboratory of the Harrison plant of the RCA Tube Division has been using the RFL Models 262B and 454B Instrument Calibration Standards to periodically check the accuracy of over 2,000 meters employed to measure receiving tube characteristics prior to shipment. Element currents, amplification factor, plate resistance, transconductance, emission, etc., are measured to fine tolerances.

According to Mr. Tomalesky, manager of the laboratory, "both Standards are in operation eight hours a day, five days a week. Only two maintenance calls have been necessary in three years. The 0.1% accuracy of Model 262B satisfies our requirement for DC meter standardizing. These two Standards have eliminated the problems associated with previous methods."

The advantage gained by in-plant calibration of electrical instruments using these console type Standards, which encompass the full range of testing instruments, under controlled laboratory conditions, goes beyond mere convenience. Their ease of operation, consistent calibration and high accuracy over wide current and voltage ranges are impossible to duplicate using individual testing equipment which must be moved from job to job throughout a manufacturing plant.

In addition to accuracy, each RFL Standard has many features which make rapid calibration procedure possible. Where many instruments must be tested, it can be demonstrated that an appreciable cost saving over older calibration methods will soon result.

Model 260C

Calibrates DC electrical measuring instruments to direct reading accuracies of 0.5% (0.25% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes.
Net price $8,975.00 f.o.b. Boonton.

Model 261B

Calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.
Net price $9,250.00 f.o.b. Boonton.

Model 262B

Calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes.
Net price $14,300.00 f.o.b. Boonton.

Write for technical data and application information.

RFL
Radio Frequency
LABORATORIES, INC.
Boonton 28, New Jersey, U. S. A.
DESIGNERS AND MANUFACTURERS OF ELECTRICAL EQUIPMENT SINCE 1922

Radio Frequency Laboratories, Inc.
Boonton, New Jersey
Please send me complete information on all Instrument Calibration Standards.

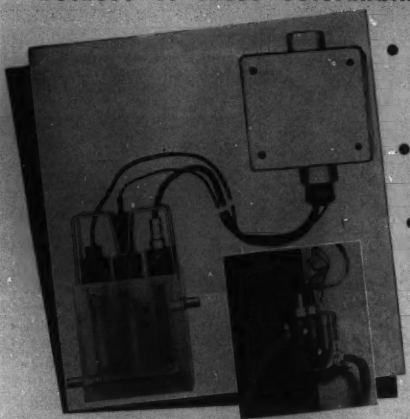
Name _____ Title _____
Company _____ Phone _____
Address _____
City _____ State _____

Leeds & Northrup Company
ELECTRODE ASSEMBLY FLOW BLOCKS

are made from

HYSOL 6000 Series
• EPOXIDE RESINS •

Because of these outstanding properties



- ONE-PIECE LEAKPROOF CONSTRUCTION
- RESISTANCE TO MANY CHEMICALS
- RESISTANCE TO ELECTRICAL PICK-UP
- MECHANICAL STRENGTH

The Leeds & Northrup "plastic flow type" electrode assembly above shows the flow block, at left, formulated from HYSOL 6000. Measuring about 4½" by 1½", it has three wells into which the pH electrodes and temperature compensator screw against sealing gaskets. Leadwires from these detecting elements are connected, in the terminal box at top, to leadwires from recording and/or controlling equipment. Insert shows the assembly in operation. The test solution flows through the block, under pressures up to 30 psi, where its pH is continuously detected by the electrodes.

HYSOL 6000 Series epoxide compounds provide the best plastic for this electrode assembly for many reasons. The block itself is produced from a single piece of plastic material. This one-piece construction provides great mechanical strength and prevents solution leakage. The fact that the flow block is chemically resistant is important, since measured solutions are either highly acidic or highly caustic. The d-c electrical insulating properties of HYSOL 6000 Series epoxide compounds minimize electrical pickup and current leakage which would create a measuring error.

Perhaps this use of HYSOL 6000 suggests a possible application for you. The HYSOL 6000 Series includes a complete line of room temperature and heat curing potting and casting compounds, easily machined sheets, rods and tubes and coating and laminating varnishes.

The skilled, experienced experts in our research, design and production departments are ready to serve you. Your inquiries will be answered at no obligation. Put Houghton Laboratories, Inc., products and personnel to work solving your plastic problems. Write, wire or phone today.

PROGRESSIVE PRODUCTS THROUGH CHEMICAL RESEARCH
HYSOL
Product of HOUGHTON LABORATORIES, INC.

houghton laboratories, inc.

105 BUSH STREET, OLEAN, NEW YORK

NEW PRODUCTS • •

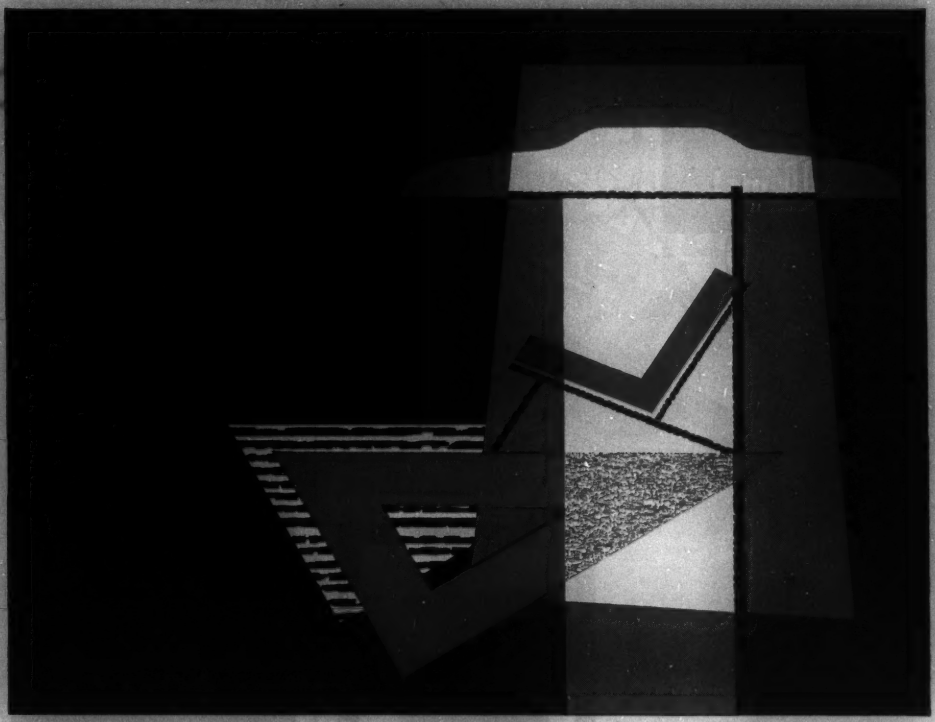
Silicon Power Rectifier. Small, light, and efficient, a silicon power rectifier is the first product to emerge from the newly established semi-conductor department of Automatic Manufacturing Corporation, subsidiary of General Instrument Corporation, 829 Newark Avenue, Elizabeth, N. J.

Designed for use in equipment where miniaturization and high temperature reliability are important, these rectifiers take up only 0.03 cubic inch, and weigh 0.07 ounce. They operate at temperatures as high as 200 C and in many cases are directly interchangeable with vacuum tubes, selenium rectifiers, or germanium junction rectifiers.

Printed Circuit Connectors. Newly developed contacts are now supplied with Continental connectors printed circuit receptacles. They are available in single and double row construction of 6, 10, 15, 18 or 22 contacts. The Bellows type design provides longer contact life and smoother engagement. The connector accepts 0.054 to 0.071 inch variation of standard 1/16-inch copper-clad printed circuit laminated card. Wiring styles include solderless wire wrap, solder lugs or taper pins for *AMP 53*. A choice of molding compounds is available: mineral filled melamine, Plaskon reinforced (glass) alkyd *440A*, and Orlon filled diallyl phthalate. For complete information write Electronic Sales Division, DeJUR-AMSCO Corporation, 45-01 Northern Boulevard, Long Island City, N. Y.

The Dalic Process. An advanced method for electroplating localized areas is available in the United States and Canada from Dalic Metachemical Ltd., 121 Leicester Avenue, Toronto, Ont., Canada, and Marlane Development Company, Inc., 153 East 26th Street, New York, N. Y. Dalic plating utilizes a newly designed group of air- and water-cooled styli and a complete range of special nontoxic metallo-organic solutions. These solutions are capable of plating small areas at high-current densities —in some cases as high as 6,000 amperes per square foot.

(Continued on page 28A)



tomorrow's design and styling ...today!

The sleek, efficient and streamlined "New Look", which characterizes the styling of Roller-Smith's entire line of indicating instruments, symbolizes the advanced thinking and improvements incorporated in the design of every integral part contained in each and every mechanism.

Specify and install them in your equipment with the complete assurance that —they are every bit "as good as they look".

Whether the instrument you buy is "standard" or must be designed and made to order—be sure its dial bears the name of the master Instrument Makers— Roller-Smith—the epitome of instrument quality for nearly fifty years.

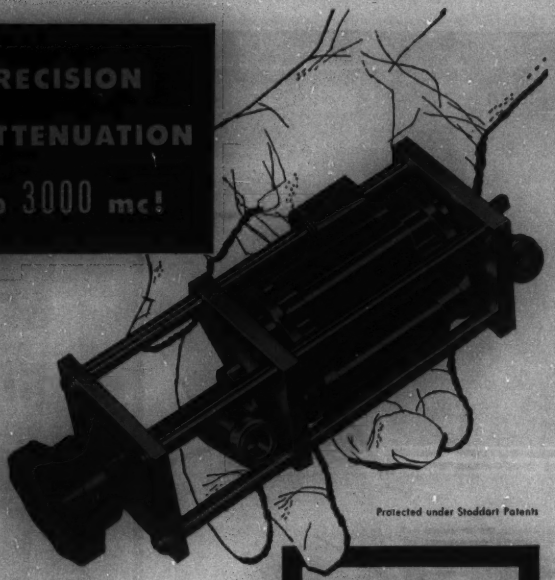
Instrument Division

CORPORATION

1825 WEST MARKET STREET ROLLER-SMITH BETHLEHEM, PENNSYLVANIA

Precision Products Since 1908

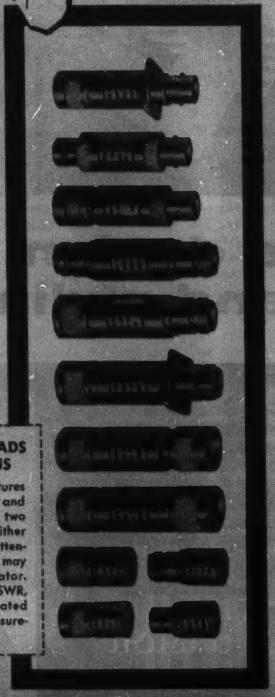
PRECISION ATTENUATION to 3000 mc!



Protected under Stoddart Patents

six-position
TURRET ATTENUATOR
featuring PULL-TURN-PUSH *action*

FREQUENCY RANGE: dc to 3000 mc.
CHARACTERISTIC IMPEDANCE: 50 ohms.
CONNECTORS: Type "N" Coaxial female fittings each end.
AVAILABLE ATTENUATION: Any value from 1 db to 60 db.
VSWR: 1.2 max., dc to 3000 mc/s, values from 10 to 60 db. As value decreases below 10 db, VSWR increases to not over 1.5.
ACCURACY: ± 0.5 db.
POWER RATING: One watt sine wave power dissipation.



SINGLE "IN-THE-LINE" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATIONS

This new group of pads and terminations features the popular Type C and Type N connectors, and permits any conceivable combination of the two styles. For example, the two connector types, either male or female, can be mounted on the same attenuator pad, with or without flanges, so that it may serve as an adapter as well as an attenuator. Frequency range, impedance, attenuation, VSWR, accuracy and power rating are as designated above. Send for free bulletin entitled "Measurement of RF Attenuation."

STODDART AIRCRAFT RADIO Co., Inc.
1535 N. Vine St., Hollywood 28, California • Hollywood 4-9294

New Products

(*Continued from page 22A*)

Resistors. Dalohm deposited carbon resistors, manufactured by Dale Products, Inc., of Columbus, Neb., have an improved coating material. The coating incorporates such features as extreme toughness for rough handling; low temperature cycling (to −85 C) resistance to humidity, and high temperature characteristics, making these resistors suitable for printed circuit solder dipping without the added space required for sleeving. Identified as Types *DC*, and *CC*, Dalohm deposited carbon resistors are available in eight standard sizes from 1/8 watt to 5 watts, and in resistance values to 500 megohms. Standard tolerance is 1 per cent.

Orthosonic Tone Arm. Tracking error, a common problem in the reproduction of recorded music, virtually has been eliminated in a new tone arm developed by the Bard Record Company, Inc., 66 Mechanic Street, New Rochelle, N. Y. This tone arm, designated the Orthosonic *V/4*, is designed so that the cartridge moves radically from the edge to the center of the record, rather than in an arc, as is the case in conventional types. Another important

advantage of the Orthosonic *V/4* is an arrangement by means of which the tone arm may be lifted and replaced at the same spot on the record, thus permitting interruptions without omitting or replacing passages. In addition, a calibrated scale makes exact cueing possible. Other features include ball-bearing suspension of the carriage assembly, pivot-mounting of the cartridge to reduce record wear, simplified counterbalancing of the stylus, small size, and easy installation.

Portable Transistorized Voltmeter. A portable voltmeter covering frequencies from 20 cycles per second to 1 mc has been developed by the Alto Scientific Company, Palo Alto, Calif. The instrument, Alto Model *D-21*, is battery powered, contained in a 5-inch high plastic case, and weighs only 30 ounces. It offers stability at all operating temperatures from 0 to 120 F, and provides instantaneous readings of voltages between 20 cycles per second and 1 mc. Accuracy is ±5 per cent. The instrument is designed for ease in all types of voltage measurements where a-c power

(*Continued on page 37A*)

(*Continued from page 28A*)

is not available, or use of battery powered equipment is more convenient. The voltmeter is transistorized, and has printed circuits for maximum ruggedness, dependability, and uniformity. Peak sensitivity is 0 to 1 millivolt and any of 12 decade (10 db) ranges may be switched on the front panel. Input impedance of 10 megohms on all ranges prevents disturbances to circuits under test. The front panel meter reads direct in db from −20 to + 2db, or volts from 0 to 1 or 0 to 3. Voltage calibration is linear. Output terminals are provided for use with monitoring devices having input impedances of 10,000 ohms and higher.

Integrating Amplifier. The AIL Type *40* integrating amplifier designed by Airborne Instruments Laboratory, Inc., Mineola, New York, is a four-tube electronic integrator for use as a component of electronic analogue computers. This new product features long memory coupled with high sensitivity, stability, and versatility. Critical circuits are hermetically sealed in a dry nitrogen atmosphere for long-term stability and resistance to humidity effects.

Measuring Device. An accurate measuring device, capable of direct linear measurements to within one millionth of an inch, has been developed by Link Aviation, Inc., Binghamton, N. Y. Called the Link Fringecount micrometer, the new unit utilizes the wave length of light as a basis of measurement. As a result, gauge blocks or other standards are not required for precision measurements. This equipment can be used in a controlled environment to measure to an accuracy of one millionth of an inch, or utilized in production work where its high accuracy will serve as a safety factor for less precise measurements. It can also be used as a precision comparator with a two-inch range of movement from the "set" position. The

(*Continued on page 38A*)

BROAD BAND PULSESCOPE

by Waterman

MODEL S-6-A

DC CALIBRATION MARKERS 1-1000 μs 0-5 mc

Size:
8½" x 6¾" x 13¾"
22 Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The S-6-A BROAD BAND Scope is a PULSESCOPE in performance, POCKETSCOPE in size, and it compares more than favorably with oscilloscopes that are *transportable*, instead of portable. The instrument measures DC as well as AC signals. Unique DC calibration methods permit rapid measurements of either positive or negative AC or DC signals. The scope uses a 3XP1 tube with 1500 volts on the second anode, thus providing a brilliant trace for high speed transients even at low repetition rates. Vertical amplifier sensitivity of 0.2v rms/inch, and response to 5 mc within 3DB . . . pulse rise time of 0.1 μs . . . internal intensity markers from 1 to 1000 μs . . . repetitive or trigger sweep from 5 cycles to 500 KC with 5X sweep expansion . . . sweep, marker and DC calibrating voltage available externally. Size 8½ x 6¾ x 13¾ in. Weight 22 lbs. Operates from 50 to 400 cycles at 115 volts AC.

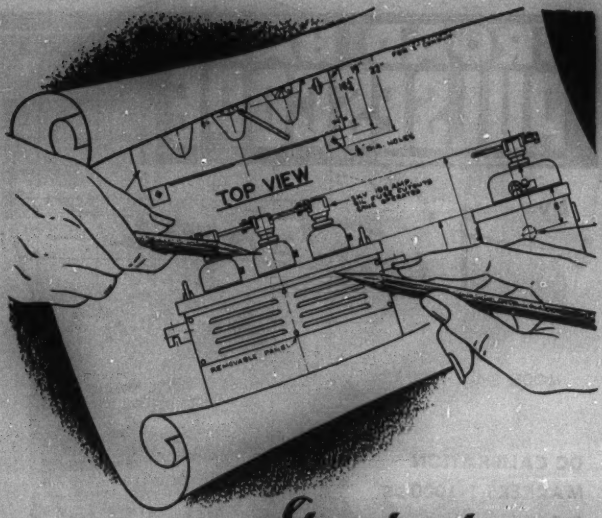
WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

WATERMAN PRODUCTS

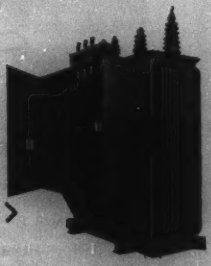
WATERMAN PRODUCTS INCLUDE

S-4-C SAR PULSESCOPE®
S-5-A LAB PULSESCOPE
S-6-A BROADBAND PULSESCOPE
S-11-A INDUSTRIAL POCKETSCOPE®
S-12-B JANized RAKSCOPE®
S-14-A HIGH GAIN POCKETSCOPE
S-14-B WIDE BAND POCKETSCOPE
S-15-A TWIN TUBE POCKETSCOPE
RAYONIC® Cathode Ray Tubes and Other Associated Equipment



Standard WORKS
WITH YOUR ENGINEERS WHEN YOU
NEED Special TRANSFORMERS

25 KVA Dry Type Load Center Transformer with primary oil-filled fused cut-outs.



1000 KVA Special Unit Sub-Station — 66,000 to 2400 volts.

Working with you, STANDARD engineers can greatly assist in planning special transformer installations for a specific need in your plant. Experienced STANDARD engineers have an excellent understanding of the particular needs of the electrical industry. Custom-designed and built transformers are their specialty. There's a STANDARD TRANSFORMER representative near you. Call him today!

THE Standard

WARREN, OHIO
REPRESENTATIVES IN PRINCIPAL CITIES

New Products

(*Continued from page 37A*)

micrometer consists of three separate units—the measuring head, a control box, and a bidirectional digital counter which displays the dimension of the part being measured.

Plug-In Tubular Capacitors. Cornell-Dubilier has announced the development of their new type *BC* plug-in paper tubular capacitors designed for use with printed circuits. These capacitors are encased in molded phenolic shells with two parallel lead wire terminals. The terminals are brought out from the end of the capacitor through a thermo setting plastic end fill compound, and are spaced a fixed distance so that they may be plugged directly into printed circuits and dip soldered. Distortion and stresses are eliminated by inserting the capacitor section in a premolded, mineral-filled phenolic shell. For other features, ratings, dimensions, and test data about the new type *BC* capacitors, send for engineering bulletin number *162*. Write to Cornell-Dubilier Electric Corporation, South Plainfield, N. J.

Transistor Kit. A new transistor kit for electronics experimenters and hobbyists has been announced by Sylvania Electric Products Inc. The Sylvania kit contains two transistors of type *2N35*, and also a *1N34A* general purpose crystal diode. A manual of practical applications which lists 28 uses for junction transistors are included. These items are all contained in an attractive kit box on which is printed the ratings and characteristics of Sylvania transistors.

Resistor. The Profilm Resistor Company, 8 Whippany Street, Morristown, N. J., has announced their *PT 1000*, a new glass-sealed carbon film resistor, which combines ruggedness and small size with exceptionally high stability. Under low power use, at any ambient temperature up to 125 C the resistors are virtually unchanging for long periods of time. Stability is better than ±0.03 per year at 0.5-watt rating and derating to zero power at 140 C. With a 1-watt rating, derating to 160 C, stability is better than ±0.1 per cent in 1,000 hours. Three months storage at 500 C has shown the seals to be vacuum tight. Ruggedness is achieved by a hard borosilicate glass envelope that is fusion-sealed to the end caps. This sealed

(*Continued on page 40A*)

BEST BRUSH... **BEST BRUSH LINE...**

NATIONAL BRUSHES
TRADE·MARK

Your best bet, *from individual application to your entire mine or mill requirement,* is "National" brushes...best because they give you maximum machine efficiency at minimum brush cost.

Here's why:

PROVED GRADES

Grades to suit every operating condition... widest selection in the industry.

RESEARCH AND DEVELOPMENT PROGRAM

Active, sustained program assures new brushes for new-design machines; continually improved brushes for existing machines.

TECHNICAL SERVICE

Helps you get best electrical performance and reduce maintenance costs...streamlines brush-buying practice.

Start saving brush dollars now in operation, ordering and handling...Specify "National" brushes and be confident of top performance throughout your mine or mill.

The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
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IN CANADA: Union Carbide Canada Limited, Toronto

THE MOSELEY

AUTOGRAF

trade mark

A PRECISION X-Y RECORDER

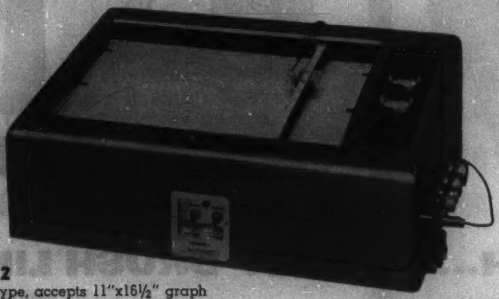
CURVE DRAWING

CURVE FOLLOWING

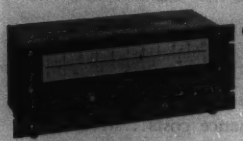
POINT PLOTTING

MODEL 1. Drum type, accepts 8½"x11" graph paper; traverses each axis in 1 second; has full scale ranges of 5 millivolts to 100 volts; zero set anywhere on the paper; portable, self-contained; available also as a curve follower for electrical read-out of drawn curves.

AUTOGRAF Recorders, MODELS 1 and 2, provide all the features needed for graphic recording of test data, point plotting, and curve following for readout purposes.

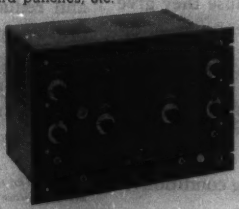


MODEL 2
Flat bed type, accepts 11"x16½" graph paper; same speeds, sensitivities and ranges as MODEL 1; zero set anywhere on paper plus one full scale length of zero-offset; inputs provided for analog recording, point plotting from digital sources, and curve following for computer or data reduction use.



MODEL 20 DC VOLTMETER is a servo-actuated, fast, accurate and sensitive instrument. Has large, easy-to-read scale for general laboratory use where ranges from 3 millivolts to 300 volts are desired. For data handling it is furnished with a built-in Coleman digitizer and delivers digital output for operation of printers, typewriters, tape or card punches, etc.

MODEL 30 CARD TRANSLATOR converts information from punched cards into point form for automatic plotting. Handles up to 50 cards per minute, 10 to 200 counts per inch. Plugs directly into MODEL 2 recorder, controls both card reader and recorder for completely automatic operation.



MODEL 40 KEYBOARD provides a convenient means for plotting large amounts of tabular data in point-curve form. Self-contained voltage source together with full three column keyboard in both X and Y axes; unit plugs directly into MODEL 2 AUTOGRAF.

Bulletins describing these instruments are available and we'll be glad to send them to you. Write . . .

P. L. MOSELEY CO., 409 North Fair Oaks Avenue, Pasadena 3, California

New Products

(Continued from page 38A)

envelope offers mechanical protection and high-temperature capability.

Device for Shadow-Free Photographs. A new piece of illumination equipment for the production of shadow free photographs in laboratory and engineering applications has been introduced. Named the Type *B* Hinelight, the device, through use of a graded circumferential tube light

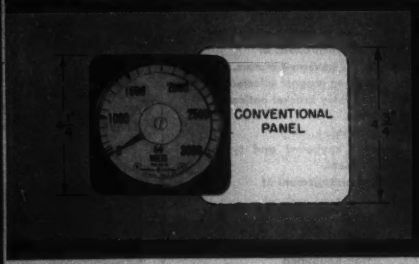
arrangement which places the camera lens inside the light source, reduces shadow in complex electronic and mechanical assemblies to the vanishing point. The feature is important when wired devices and other subjects of irregular or complex construction are to be photographed. The unit can be operated by anyone with basic information concerning focus and exposure. It is valuable in the preparation of engineering reports, Government manuals, instruction books, visual training and assembly guides, and patent applications. Details are available from the Hinelight Corporation, 2500 John Street, Fort Wayne, Ind.

New Screen Process Ink. Naz-Dar printed circuit (P.C.) Black is a free flowing screen process ink designed to meet the requirements of printed electronic circuitry. Its opacity allows it to lay an unbroken resist line of hairline accuracy without blobbing or breaking the circuit. Commonly used etching chemicals have no effect on this ink once it is applied to the printing blank. P.C. Black recommends itself to volume production of printed circuits in the way it reacts instantly to petroleum solvents. All traces of the resist vanish within seconds after hitting the solvent bath, and the completed circuit remains without a break. This ink is available in two types: one which may be air-dried for normal production, another can be heat-dried for accelerated volume. Although black has proved to have the highest visi-

(Continued on page 44A)

Make Panel Space Pay its Way

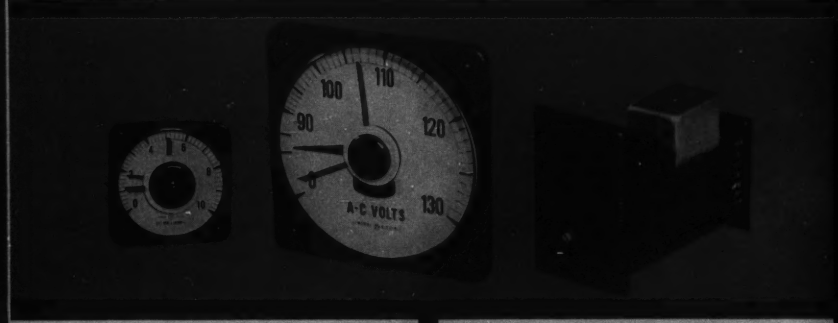
G-E small-size instruments fit 25 to a 24-inch square



½-IN. SMALLER than conventional makes, General Electric's 4¼-in. miniature permits economical use of panel space. You can mount twenty-five on a 24-in. square.

TELESCOPIC READABILITY is an inherent feature of the larger 8¾-in. instrument—ideal for locations where convenience dictates taking readings at extra-long distances.

NEW FEATURE INITIATES CONTROL



NEW CONTROL INITIATION for G-E switchboard and panel instruments provides a simple, reliable means to automatize your operations. This contactless all-electrical unit, using industry-tested components, automatically initiates action whenever the instrument indicates a predetermined value. Available on new instruments, the feature can also be added to instruments in service.

For further details, contact your nearest G-E Apparatus Sales representative, or send the coupon shown at the right for a copy of Bulletin GEA-6325.

SECTION G602-289
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, NEW YORK

Please send me your bulletins:

- ☐ **AB-DB 18 and 16 long-scale switchboard instruments (GEC-218)**
- ☐ **Control initiation for instruments (GEA-6325)**

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GENERAL ELECTRIC

STANDARD TELETYPEWRITERS AND RECTIFIERS

A wide range of standard teletypewriters and accessories are available for early delivery from current production. These machines are assembled from parts produced by a leading American manufacturer and are standard and interchangeable in every way. They can be supplied in either commercial or military packing, with instruction books. All units carry a 12-months' guarantee. We stock spare parts.

The following types of teletypewriters are available:

- Model 15 Page Printer.
- Model 19 Page Printer.
- Model 14 Tape Printer.
- Model 14 Typing Reperforator
- Model 14 Transmitter-Distributor.
- Type TG-7A or TG-7B Teletypewriter (U.S. Signal Corps version of Model 15)
- Type TG-26 Teletypewriter (U.S. Signal Corps Typing Reperforator Transmitter-Distributor Set).
- Type TT-7 Teletypewriter (U.S. Signal Corps version of Model 19)

Teletypewriters can be supplied in the following optional arrangements:

- Send and receive or receive only.
- 50 or 60 cycle synchronous or governed, or d-c governed motors.
- Holding or pulling-magnet selectors.
- Line relay and relay bracket optional.
- Tables optional.
- Rectifiers optional.
- Any standard keyboard and type-pallet arrangement.
- Any standard arrangement of functions.

Rectifiers: Input 115v 50-60 cycles A.C. Output 115 volts D.C.

Regulated		Non-Regulated	
Type	D-C Amps.	Type	D-C Amps.
REC-13	0.6	F11360	0.2
F3901	0.8	REC-4	0.25
RA43	4.5	RA-87	0.4
		F8387	0.6
		K35988	0.8

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SELENIUM RECTIFIERS

Here are "Dry-Plate" Rectifiers that you can count on for low cost, efficient results. You get the same uniform, high quality with each cell because they're manufactured by perfected, vacuum process. Widest range of cell sizes to choose from. Fungus and salt spray resistant finishes available.

Write For Catalogue FREE

SYNTRON COMPANY
440 Lexington Ave. Homer City, Pa.

New Products

(*Continued from page 40A*)

bility factor in this product, the P.C. line is available in any standard color. For information, write to the Naz-Dar Company, 461 Milwaukee Avenue, Chicago, Ill.

Automatic Code Converter. Automation has recently been applied to the reception of international Morse code radio signals. CGS Laboratories, Inc., of Stamford, Conn., has produced an automatic "robot" that converts international Morse code into standard teleprinter page copy ready for reading. The device, termed the Trak Automatic Code Converter, is the

latest among several specialized types of communication equipment manufactured by the company for both commercial and military radio communications. The code converter is an all electronic computer that accepts the signals from a regular radio receiver and translates them into suitable electric pulses for a standard teleprinter, which prints the message text on the equivalent of an automatic typewriter. Thus, one is able to read the printed message exactly as transmitted at the point of origin. In addition to copying Morse signals directly from the air, the converter also will work on signals produced by hand or machine keying. Its output can operate reperforator equipment or key land-line loops to remote teleprinter units.

Plug-In Panelboard. A plug-in type panelboard with a breaker having an exclusive right-angle Swinggrip mounting feature has been announced by the Square D Company, Detroit, Mich. The *NQO* panelboard, with *QO* breakers, can be used for both a-c lighting and appliance branch circuit applications, and is available with main lugs only, or main breaker. Available either off-the-shelf or factory assembled, the *NQO* comes in 14, 20, 30, or 42 circuit combinations. This compact, rugged panelboard requires a box only 14-inches wide and is ideal for mounting between wall studs on 16-inch centers. Narrow width interiors allow generous wiring space. Fronts with doors are available for

(*Continued on page 46A*)

now gathering answers for tomorrows' problems

To the problems of insulation for extra-high voltage, multiple conductors add unanswered questions about special hardware. We're busy now gathering experience—laboratory experience—in this extra-high voltage transmission technique, at the Ohio Brass Barberton Laboratory.

Here, men who work daily with insulation *and* hardware investigations are in a unique position to examine the performance of insulator-hardware combinations needed for multiple conductor, extra-high voltage transmission.

Add to this the knowledge O-B development people have gained in the design and installation of multiple conductor lines already in use! Ohio Brass is already rich in knowledge of techniques that may be as much as decades away for commercial extra-high voltage transmission.

Constant research is a portion of the technical competence that keeps Ohio Brass ready to cope with every new industry problem. This competence can be helpful to any power company now studying EHV possibilities. Call on us!

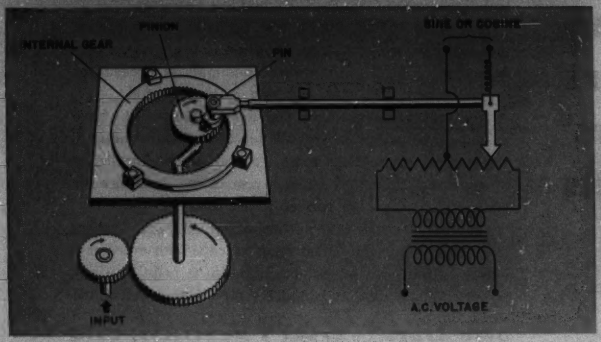
OHIO BRASS COMPANY • MANSFIELD, OHIO

Control rings and associated hardware developed for dual conductors in a 345-kv application. Only Ohio Brass offers an organization adequately equipped to design, produce, and test this equipment for extra-high voltage transmission.

Ohio Brass

4549-H

SINCE 1915 LEADERS IN AUTOMATIC CONTROL



Ingenious electro-mechanical device generates sine or cosine function

From a combination of mechanical and electrical principles, Ford Instrument Company engineers have produced and patented an electro-mechanical device to generate sine and cosine functions. The mechanical portion is an internal-gear angle resolver. It consists of two gears — an internal gear and a pinion. Because the pinion has exactly half the number of teeth as the internal gear, the pin on its pitch circle traces a straight line when the pinion rolls inside the angle gear.

Furthermore, the displacement of the pin relative to the center of the internal gear is proportional to the sine (or cosine) of the roll angle of the pinion.

If a linear potentiometer is now placed along the diameter of the internal gear and a potentiometer slider is fastened to the pin on the pinion, the voltage picked off by the brush is proportional to the sine (or cosine) of the angle.

Two such systems, connected in tandem, produce simultaneously both the sine and cosine functions.

This is another example of Ford Instrument engineering ingenuity. What appears on the surface to be a complex problem is solved by the combination of well-known principles.

Perhaps you have a problem that could benefit from Ford Instrument experience. Ford Instrument engineers work every day with systems using mechanics, electronics, hydraulics, electro-mechanics, magnetics, atomics. How can Ford help you?

79

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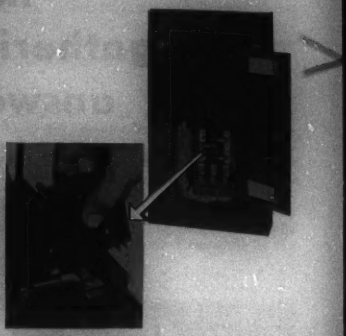
ENGINEERS
of unusual abilities can find a future at FORD INSTRUMENT COMPANY. Write for information

New Products

(*Continued from page 44A*)



either surface or flush mounting. For more information about *NQO* panelboards and *QO* breakers, consult Square D Company, 6060 Rivard Street, Detroit 11, Mich.

Junction Transistors. The Radio Corporation of America's Tube Division has announced two new alloy junction transistors—*2N77*, and *2N105*. The germanium p-n-p types are designed for low-power, audio-frequency amplifier service. These transistors are hermetically sealed, utilize insulated metal envelopes, and have flexible leads. The body of the *2N77* is approximately 1/4 inch in diameter and 3/8 inch in length, whereas the body of the *2N105* is approximately 1/8 inch in diameter and 1/4 inch in length. These transistors feature a low base lead resistance which minimizes ohmic losses, improves frequency response, and insures high input-circuit efficiency.

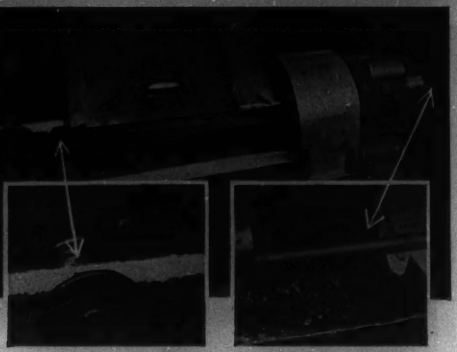
Tiny Photoconductive Cell. A very small cadmium-sulfide photoconductive cell of the head-on type designed for light applications where a single tiny photosensitive device is required, has been introduced by the Tube Division, Radio Corporation of America. The new cell, *RCA-6694*, features high luminous sensitivity, low background noise, and a signal output which is directly proportional to the intensity of the light falling upon the cell. The *RCA-6694* is useful for light-controlled delay applications, in computer systems, and in light meters for measuring the brightness of small luminous spots. The cell's spectral response covers the visible range from 3,500 to 5,500 angstroms with maximum sensitivity in the green region of the spectrum. The *6694* has a maximum length of only 0.19 inch, a maximum width of 0.34 inch, and a maximum depth of 0.185 inch. Minimum photosensitive area is 0.02 by 0.018 inch. Ratings, characteristics, and operating considerations are included in a technical bulletin available from RCA Tube Division, Harrison, N. J.

Gas Thyratron Tube. A gas thyratron tube of the negative-control tetrode type has

(*Continued on page 54A*)

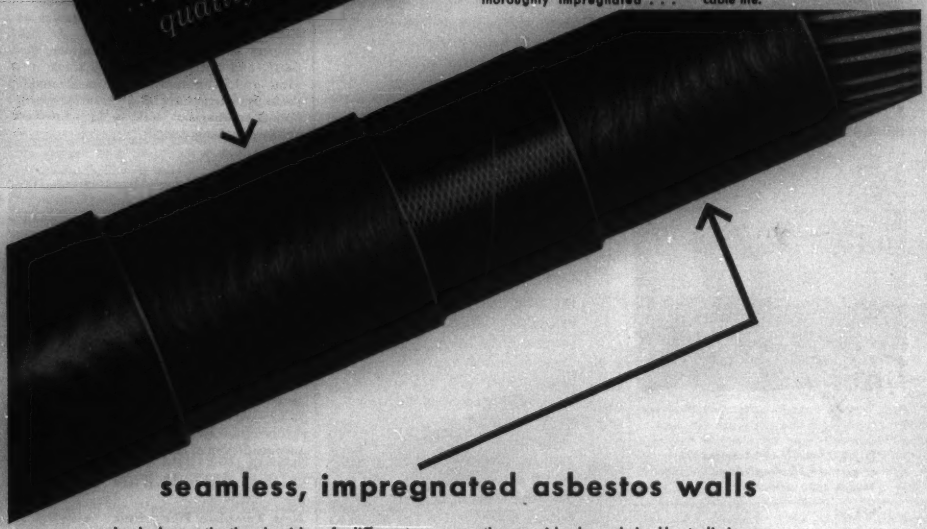
look beneath the braid

...that's where quality begins



Heavy, felted asbestos walls are applied over and under the varnished cambric tapes . . . then thoroughly impregnated . . .

then the impregnated asbestos is compressed to a dense, homogeneous wall that ensures long cable life.



seamless, impregnated asbestos walls

Look beneath the braids of different kinds of N.E.C. Type AVA wire or cable. For the longer life that means real economy, look for the seamless, felted asbestos walls of *Rockbestos* A.V.C. Type AVA.

Each asbestos wall in *Rockbestos* A.V.C. is a dense, non-porous, *permanently* heat-resistant wall . . . a homogeneous "seamless tube" made of long, silky asbestos fibers felted to form a continuous wall under and over the varnished cambric. Heat dissipation is uniform. Dielectric strength is high and stays high. The seamless construction gives added strength against bending stresses.

Get the complete story on the construction and test specifications of *Rockbestos* A.V.C. Type AVA in the new booklet: "Specification RSS-88". Write for your copy now.

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Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.

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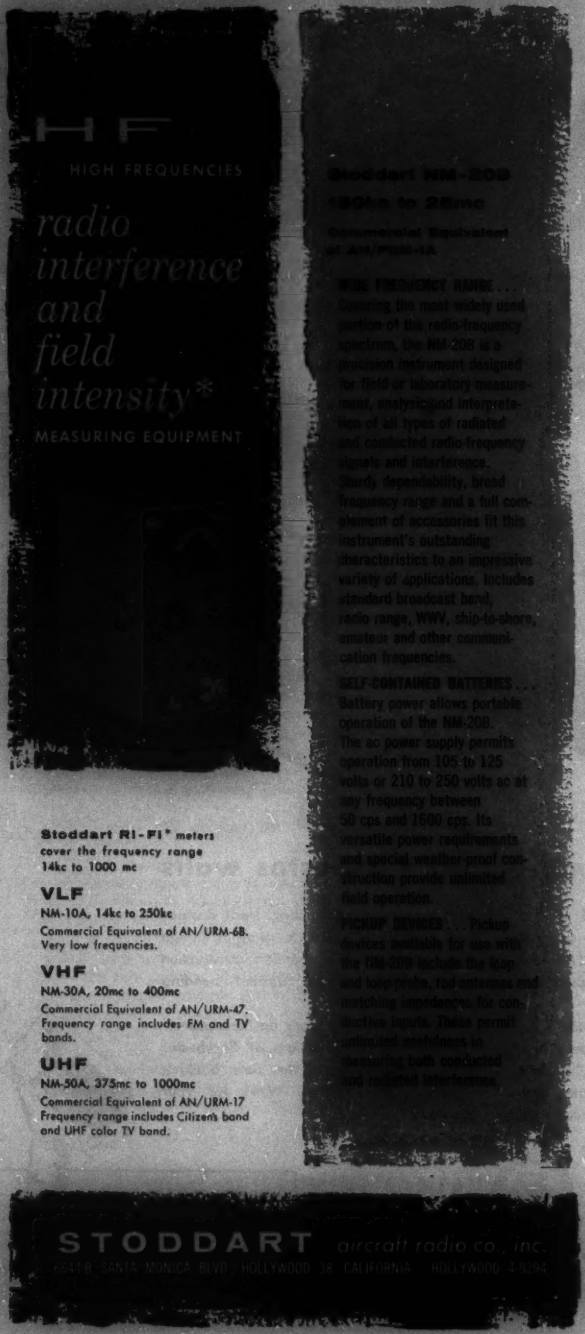
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Commercial Equivalent of AN/URM-47. Frequency range includes FM and TV bands.
UHF
NM-50A, 375mc to 1000mc
Commercial Equivalent of AN/URM-17 Frequency range includes Citizen's band and UHF color TV band.
STODDART aircraft radio co., inc.
6644 SANTA MONICA BLVD. HOLLYWOOD 38, CALIFORNIA HOLLYWOOD 2-3046

New Products

(Continued from page 46A)

been announced by the Tube Division, Radio Corporation of America. The tube, *RCA-3D22-A*, is a sensitive 4-electrode thyratron with indirectly heated cathode and was designed for use in relay and grid-controlled rectifier applications, particularly those involving motor-control service. The *3D-22A* employs a sturdy, compact single-ended construction which eliminates bulb terminals with their attendant flexible leads. The tube's full ratings may be used at altitudes up to about 10,000 feet.

Transparent, Dimensionally Stable Film. A reproduction material, Stabilene film, has been gaining a reputation in the field of Government map making because of its high transparency and dimensional stability. It has been made available by Keuffel and Esser Company of Hoboken, N. J. Such features as fiber-free drawing surface, flexibility, and initial tear strength make it an ideal product for many other uses like making patterns or templates on work surfaces or for optical comparator work, or in printed circuits and wiring design.

Dekabridge. Electro-Measurements, Inc., Portland, Ore., has expanded its line of precision laboratory instruments to include a new package styling for Wheatstone bridge circuit. Manufactured under the tradename Dekabridge, model *210*, this instrument has been designed with the human engineering aspect in mind. The over-all Wheatstone bridge operation has been simplified with a net result of increased operating speed with improved accuracy. The limit of measurement error on all ranges is 0.1 per cent. This accuracy is achieved by using resistors which are unifilar wound on thin mica cards with Evanohm wire throughout the bridge. Evanohm wire has a temperature coefficient of ±0.002 per cent per degree centrigrade.

New Template Filing Unit. A system for filing and storing templates, patterns, gaskets, and flat tools has been announced by the DeLuxe Metal Furniture Company, 306 Struthers Street, Warren, Pa. Called templa-file, this equipment contains 24–36 by 80 inch numbered sliding panels. Each panel is suspended on rollers operating on roll-formed track. The capacity (storage area) of the unit is 2,880 square feet. Each panel will support 600 pounds of suspended weight.

High Output Temperature Probes. High resistance (20,000 ohms) temperature probes, when used with bridge network, provides 5-volt output signals, without amplification, for as little as 150° temperature change. Manufactured by the Armoux Corporation, Department EE-4, Box 34628, Los Angeles, Calif., these probes are available in varied configurations for measuring fluid, surface, structure, air, hydraulic line, cylinder head, and subminiature component temperatures.

(Continued on page 56A)

DOW CORNING CORPORATION

Silicone Dielectrics

ELECTRICAL AND ELECTRONIC NEWS No. 2

SUNBEAM "FRYPAN": CASE HISTORY OF AN ADVANCED DESIGN MADE PRACTICAL BY SILICONE DIELECTRICS

Ingenious design and resourceful use of materials is reflected in the Sunbeam Automatic Frypan, an attractive and original new household appliance, which combines the appeal of a built-in source of controlled heat with the convenience of easy, thorough washability.

These ideal features were made practical through the use of Dow Corning silicone dielectrics. The completely enclosed lead and thermocouple wiring, for instance, is insulated with Silastic*, the Dow Corning silicone rubber. Silicone-glass sleeving is also slipped over the wires to assure maximum dependability at operating temperatures in the range of 450 F. And the terminal block to which they are connected is a heat resistant silicone-glass laminate.

Although the Frypan may be almost totally immersed in water, the electrical connections at the base remain dry and easily accessible inside a terminal box sealed with molded Silastic. Extensive research and testing, including several thousand actual immersions, have proved that this gasket maintains a watertight seal even after prolonged exposure to temperatures in the range of 450 F. *No. 6*

ELECTRIC RANGE CONTROL SYSTEM INSULATED WITH SILICONE RUBBER

The heart of the Westinghouse "Electronic Eye" heat control system for electric range surface units is a thermistor embedded in Silastic*, Dow Corning silicone rubber. Flexible Silastic insulated cable connects the thermistor to exterior wiring, and the Electronic Eye itself is isolated in the center of a flexible diaphragm of Silastic. The Silastic components have stood up under boiling water, oil, grease, coffee and syrup, as well as accelerated life testing equivalent to 15 years of actual service. *No. 10*

Dow Corning 220 Fluid, a special silicone fluid for sound transducers, has sound transmission characteristics similar to those of water, a freezing point below —65 F, and a flat viscosity temperature slope. Dielectric strength is 200 volts per mil; volume resistivity is 10^{12} ohm cm. *No. 11*

Silicone Molding Compound Qualifies For Guided Missile Service At 750 F

Light weight, high mechanical strength, good dielectric properties and excellent heat resistance motivate the use of a terminal block molded of Dow Corning 301 Molding Compound with brass inserts in an induction potentiometer produced by American Electronics of Culver City, California. Designed for aircraft and guided missile service, the unit is built to operate in ambient temperatures as high as 750 F.

To qualify for the job, the molded parts withstood five room temperature shock tests at 50 "G's" plus constant vibration in the order of 25 "G's" for 4 hours at 600 F. Finally, the potentiometer was subjected to 1050 F for 15 minutes. The terminal blocks molded of Dow Corning 301 Molding Compound were somewhat shrunken and charred, but the brass inserts were still firmly retained. *No. 9*

Silicone dielectrics most widely used are described in the 1955 Reference Guide to Dow Corning Silicone Products. The brief but comprehensive description of each material includes a review of properties and applications. With increasing demands for high temperature operation, such a guide to these remarkably stable dielectrics should be immediately available to every electrical engineer. *No. 7*

"What's a Silicone?" is the title of a 32 page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 8*

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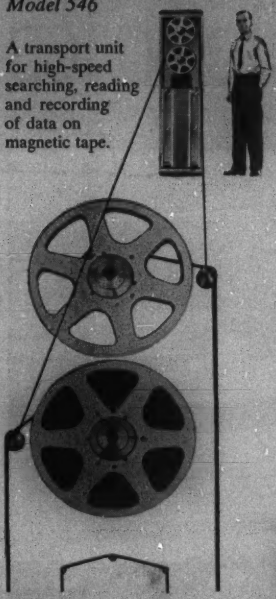
Canada: Dow Corning Silicones Ltd., Toronto; Great Britain: Midland Silicones Ltd., London; France: St. Gobain, Paris

DataReader

Model 546

A transport unit for high-speed searching, reading and recording of data on magnetic tape.



End-of-tape sensing

Slotted, hollow guide shafts, one adjacent to each tape reel are constantly subjected to a vacuum which is maintained as long as normal tape is passing over, and sealing the shaft openings. Perforated leaders at either end of the tape interrupt the vacuum and stop the tape reels. This feature also provides an automatic stop in the event of tape failure.

PERFORMANCE:

RAPID START—STOP—REVERSE—from stop to full speed in 6 milliseconds.

HIGH TAPE SPEED—optional single speed of 30, 40, 50, 60 or 75 in/sec.

TWO-DIRECTION SEARCH—either direction, automatically at full speed.

REMOTE OPERATION—forward, reverse, stop, rewind and selection of reading and writing.

VACUUM COLUMN TAPE CONTROL—provides strain-free tape feed over entire length of tape.

RAPID REWIND—2400 ft. of ½" or ¾" tape in 3 minutes.

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Available in the following frequency ranges:

Model 59-LF	0.1 to 4.5	Mc
Model 59	2.2 to 420	Mc
Model 59-UHF	420 to 940	Mc

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New Products

(Continued from page 54A)

Radio-Frequency Bridge. An improved version of the r-f bridge has been developed by General Radio Company as the type *1606-A* radio-frequency bridge. Retaining all the desirable features of the older type *916-A*, the new instrument adds several new ones to increase ease and convenience of operation. The most significant improvement is the broadband bridge transformer which covers the entire bridge range from below 400 kc to 60 mc. New milled-plate variable air capacitors, which have very low losses, are used as reactance standards. Connections to the unknown are facilitated by the removal of the resistor previously mounted in the connecting lead. The size of the bridge has been reduced so that the volume of the new instrument is only one half the previous model.

TRADE LITERATURE

New Bulletin on Vault-Type Power Units. Allis-Chalmers factory-assembled vault-type power units designed to provide an economical and compact source of electricity in limited space areas are described in a new bulletin released by the company. The power units are designed to supply 3-phase or a combination of 3-phase and single-phase service and consist of three or four single-phase transformers and metering transformers in a single tank. Copies of the bulletin, "Allis-Chalmers Vault-Type Power Units," *61B8208*, are available on request from Allis-Chalmers Manufacturing Company, 931 South 70th Street, Milwaukee, Wis.

1956 Electric Tool Catalogue. A new 25-page, 1956 catalogue describes 52 portable electric tools and kits with over 400 accessories. This free book includes 150 illustrations of tools and their uses. Write for catalogue number *102*, to Porter Cable, 58 Exchange Street, Syracuse, N. Y. (In Canada, write Porter-Cable Power Tools Ltd., Box 5019, London, Ontario.)

Tables and Data. The United States Testing Company, Hoboken, N. J., has announced publication of a booklet entitled "Selected Scientific and Engineering Tables and Data." Issued in commemoration of the company's 75th anniversary, the booklet is composed of many types of technical information, reflecting the many fields of activity of this organization. This 112-page paper-bound volume contains selected chemical and physical, engineering, plastics, bacteriological, leather, psychometric, and textile tables and charts, arranged for easy reference. Copies of the booklet may be obtained by writing on company letterhead to H. M. Block, vice-president, Hoboken, N. J., or to the branch manager of any of the Testing Company's branch laboratories.